

DEAN'S COMMITTEE REPORT

For

the Faculty

of

Bachelor of Technology

(Agricultural Engineering)

STATE AGRICULTURAL UNIVERSITIES OF GUJARAT

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Chapter 1

Sixth Deans' Committee: Terms Of Reference

1.1 Constitution of Committee for drafting the Implementation Strategy for Higher Agriculture Education

As a follow up to the National Education Policy-2020 (NEP 2020), ICAR, as Professional Standards Setting Body (BSSB) of agricultural education for the NEP-2020, set up a high-level committee comprising of the Vice Chancellors of Agriculture Universities. It was asked to devise a strategy for implementing NEP-2020 in agricultural education. Besides several other recommendations, the high-level committee recommended the constitution of 6th Deans' Committee for restructuring the course curricula, framed by the 5th Deans Committee. Universities have adopted the 5th Deans Committee for implementation during the past few years. The NEP-2020 required that this course curriculum is restructured to fit into the new academic regime.

1.2 Notification for Setting up the Sixth Deans' Committee

On the Recommendations of ICAR-NEP Implementation Strategy Committee, ICAR constituted the 6th Deans' Committee on August 17, 2021 (orders issued on Sep 15, 2021) vide notification *F. No. Edn.5/24/202/EQR/VI Deans*. The 6th Deans' Committee was mandated to restructure the existing course curricula so as to enable implementation of NEP 2020 in agricultural education.

1.3 Terms of References of the 6th Deans' Committee

- i) **Restructuring of all UG Programs**, All UG programs to be restructured as per NEP 2020 and NHEQF.
- ii) **Structure of first year UG Certificate Course**, areas, end of course test and criteria for entry into second year Diploma course as per provisions of NEP 2020
- iii) **Admission Criteria for UG-Certificate and UG Diploma courses**, in view of the multiple entry and exit system provision under NEP.
- iv) **Guidelines for Entrepreneurship** of students
- v) **Guidelines on provision for increasing gross enrolment ratio (GER)**, progressively.
- vi) **Defining UG and PG degrees** for general market needs, as well as for specialist jobs and **uniformity in UG and PG degree nomenclature**.
- vii) Any other point related to NEP-2020.

Chapter 2

Prologue

2.1 Aim of Restructuring Agricultural Education

Education is at the heart of both personal and community development; its mission is to enable each of us, without exception, to develop all our talents to the full and to realize our creative potential, including responsibility for our own lives and achievement of our personal aim. There is therefore every reason to place renewed emphasis on the moral and cultural dimensions, apart from what is taught presently, enabling each person to grasp the individuality of other people and to understand the world's progression towards an uncertain future.

The 21st century is showing all signs of providing unprecedented means for communication and for the circulation and storage of information. Therefore, it will impose on education two demands which at first sight may appear contradictory. Education must transmit, efficiently and on a massive scale, an increasing amount of constantly evolving knowledge and know-how adapted to a knowledge driven civilization, because this forms the basis of the skills of the future. At the same time, it must find and mark the reference points that will make it possible, on the one hand, for people not to be overwhelmed by the flows of information, invading the public and private domains and, on the other, to keep the development of individuals and communities as its end in view. Education must, as it were, simultaneously provide maps of a complex world in constant turmoil and the compass that will enable people to find their way in it.

In this view of the future, traditional responses to the demand for education that are essentially quantitatively, and knowledge based are no longer appropriate. It is not enough to supply each student with a store of knowledge to be drawn on from then on. Instead, everyone must be equipped to seize learning opportunities throughout life, both to broaden her or his knowledge, skills, and attitudes, and to adapt to a changing, complex and interdependent world.

2.2 Four Pillars of Education

The International Commission on Education in its report "Learning: The Treasure Within" (UNESCO, 1996) has defined "why and how" agenda for modifying education for 21st century, globally. It advocated inclusion of the concept of following four pillars of education if education is to succeed in its task. NEP also has advocated similar perspective of future education system in India. Sixth Deans' Committee would like to lay stress on institutions to reorganize their existing academic system of agricultural education around these four fundamental types of learning. In a way these pillars must remain the pillars of knowledge, throughout a person's life.

1. *Learning to know*, that is acquiring the instruments of understanding.
2. *Learning to do*, to be able to act creatively on one's environment.
3. *Learning to live together*, so as to participate and cooperate in all human activities.
4. *Learning to be* an essential progression which proceeds from the previous three.

These four paths of knowledge, all form a whole with many points of contact, intersection, and exchange among them.

2.3 Constitution of the report

The report is in two parts; PART-I comprises of General Report on curriculum and credits as well as other general guidelines on admissions, evaluations, etc. that is applicable to all disciplines, colleges, universities, institutions, who are involved in imparting higher agricultural education in any of the following ways in the country.

PART -II of the report comprises discipline wise recommendations, on restructured course curricula of undergraduate degree programs, for 13 ICAR approved disciplines.

Chapter 3

Highlights and New Initiatives

As per the NEP 2020 recommendations, the Sixth Deans' Committee has incorporated several new initiatives in the proposed restructured UG curricula.

3.1 Classification of level of courses with targeted outcomes

- The 1st year of the UG programme (*NHEQF Level 4. 5*) includes the Foundation courses, introductory courses and skills enhancement training/ training in the chosen area, ability enhancement courses. It is aimed that the student will acquire the basic knowledge in respective disciplines and adequate skill in some selected areas, to enable him for employment/ entrepreneurship.
- The 2nd year (*NHEQF Level 5*) includes the basic core courses and additional skill enhancement in chosen areas/ courses. It is aimed that the student will acquire the higher level knowledge in respective disciplines and adequate skill in some selected areas, to enable him for employment at middle level/ supervisory level or for entrepreneurship.
- The 3rd year includes the advanced core subjects and their practical applications with an objective that the student will have deeper understanding of the subjects and their major application areas
- The 4th year (*NHEQF Level 6*) will have the specialization/ elective courses and advanced skill enhancement through project and internship. The student will acquire advanced knowledge and skill in different areas so as to meet the higher order requirements of the society and industry as well as other prospective employers. It will also enable the graduates to become a job provider rather than being a job seeker through establishment of enterprises in concerned fields.

3.2 Multiple Entry and Exit

There is provision of multiple entry and exit at different levels. The student has the option to exit after the 1st year. He has to complete 10 weeks of internship (10 credits) after 1st year to be eligible for award of UG-Certificate. The student has another option to exit after the 2nd year. The student has to complete another 10 weeks of internship (10 credits) after 2nd year to be eligible for award of UG-Diploma.

After four years of study, the student will be awarded UG degree in concerned discipline. No 3rd year exit is recommended considering the professional nature of the courses.

The lateral entry at 3rd semester will be for the candidates having UG-certificate or those who have completed Diploma (3 years course after 10th) in polytechnics. The lateral entry in 5th semester will be for candidates who have completed UG-Diploma.

3.3 New courses for acquiring advanced knowledge and skill and for strengthening their cultural and ethical values through choice based programmes

3.3.1 Deeksharambh (Introduction--cum foundation course)

A course entitled “*Deeksharambh*” (0+2) (Non-gradual) will be offered at the start of first semester for two weeks’ duration. This will create a platform for students to learn from each

other’s life experiences, help for cultural Integration of students from different backgrounds, know about the operational framework of academic process in university, instilling life and social skills, social Awareness, ethics and values, team work, leadership, creativity, etc.. It will also help in identifying the traditional values and indigenous cultures along with diverse potentialities both in indigenous and developed scenario. There will be sessions by alumni, business leaders, outstanding achievers in related fields, people with inspiring life experiences as well as the University academic & research managers.

3.3.2 Common courses

The following common courses have been proposed to be offered across the disciplines. This will enable the student for better communication skills and personality development as well as to have a broader view of agriculture and allied sectors, which will allow them for future collaboration with other sectors to face the next generation challenges from a holistic point of view.

- Farming based livelihood systems
- Entrepreneurship Development and Business Management
- Agriculture Marketing and Trade
- Communication Skills
- Personality Development
- Environmental Studies and Disaster Management
- Agricultural Informatics

In addition to the “*Deeksharambh*”, the courses as Physical Education, First Aid, and Yoga Practices, NCC and NSS have also been made compulsory for students for better social awareness and health of the future generation.

3.3.3 New age courses

New age courses like artificial intelligence, robotics, machine learning, etc. have been incorporated into the course curricula. Besides an array of elective courses have been included so that the student can get deeper knowledge and understanding in the subject of his interest. Due emphasis has been given to include the latest topics and subjects in both core and elective courses. Practical exercises and teaching methodology are proposed to make the young generation more imaginative, innovative, ingenious, creative and competent.

3.3.4 Online courses

The students will have to take a minimum of 10 credits of online courses, which will comprise of one or more courses, as a partial requirement for the UG programme. The online courses can be from any field such as Basic Sciences, Humanities, Psychology, Anthropology, Economics, Engineering, Business Management, Languages including foreign language, Communication skills/ Music, etc. and can be taken from any online portal. The objective is to allow the students to groom their passion or strengthen their knowledge and competency in any field beyond prescribed courses.

3.3.5 Elective courses

The institutions will offer a basket of Elective courses to be offered to the students. The students will have the freedom to choose a subject among these courses. The institutions should develop capabilities to offer maximum of the Elective courses proposed in this report.

The institutions will also have the liberty to develop new Elective courses as per local needs and available expertise.

3.4 Imparting Traditional Knowledge, Values and Ethics

Due emphasis has been given for imbibing the traditional knowledge, values and ethics among the students through different courses like the *Deeksharambh*, NCC/ NSS/ NSO. It is proposed the 'Study tour' shall be conducted across the country to be aware about the socio-cultural-economic status of the people of the country and develop respect for their values and ethics.

3.5 Entrepreneurship development as a career path

The restructured undergraduate curricula are designed to enable the students to take up entrepreneurship as a career path. As per NEP, the curricula in all the disciplines of Agricultural education have been refined and fine-tuned with intensive focus on choice-based skill enhancement programs.

Skill enhancement courses are included in different modes as follows.

- Skill enhancement courses in the 1st year and 2nd year as part of the course programmes
- Internship for exit programs after 1st year/ 2nd year
- Advanced skill enhancement through Student READY programmes such as in-plant training/ internship/ projects in 4th year

The skill set acquired must make them proactive, pioneering, prospect oriented during their internship or industrial attachment to serve as apprentices in the relevant field and will empower them to grasp viable avenues of self-employment and entrepreneurship along with diversified career options in different facets of related domains.

3.5.1 Skill Enhancement Courses

Skill enhancement programmes are essential requirements for any programme (UG-Certificate/ UG-Diploma or Degree). Skill enhancement programmes will be choice based; student can choose the areas of skill enhancement from a basket of skill enhancement modules offered by the parent institution. The institutions will develop capabilities for offering such courses.

An institution is at liberty to (and in fact, it should) work in partnership with capable organizations/ companies/ NGOs/ progressive entrepreneurs/ farmers for running various skill enhancement programmes.

The University/ HAEIs may also formulate and offer courses in any other areas as identified by it, based on institutional expertise/ capabilities/ resources. In addition, the skill enhancement courses suggested by the UGC, may also be offered.

3.5.2 Internship

Those students who wish to exit with UG-certificate after one year, has to undergo 10 weeks of internship programme (10 credits) after 1st Year. Similarly, the students who wish to exit with UG-Diploma after second year, has to undergo 10 weeks of internship programme (10 credits) after 2nd Year. The goal of Internship at exit for UG-Certificate and UG-Diploma is to further strengthen skills in the chosen area/ subject.

Internship should be preferably arranged outside of the parent institution at any assigned organization/ industry/ research institution/ project or with a progressive farmer/ agri enterprise, etc.

3.5.3 Projects

For some disciplines, Projects have been kept as an integral part of the course programme. This will enable the students to develop required competencies and skill in either research or entrepreneurship or potential employment avenues rather than having only mere qualifications, choose appropriate career in research or employment/ entrepreneurship, discover his/ her interests, aptitudes and potentialities and maximise his/ her potentialities and self-confidence. It will also add to creativity and critical thinking of the students.

3.6 Light but tight educational programme

As per the norms of the NEP 2020, the programme has been made light but tight for the students. The total credit hours have been kept at 167 considering the specific need of the professional courses. At the same time, the students have been given the option of the skill development courses, internship, online courses, etc., which will make their learning experience pleasurable and learning more efficient.

3.7 Progressive evaluation

In the course programme, 20% has been kept for progressive assessment of the student within the semester in form of quizzes/ group assignments. The assessment of the students through quizzes should focus on their critical thinking and creativity rather than rote reading.

The quiz and progressive assessment can also be considered in form of group assignments (which should encourage creativity, critical thinking and problem solving attitude).

3.8 Academic Bank of Credit

As per NEP guideline, the HAEI will create an Academic Bank of Credits (ABC) of each student and recognise the ABC of a student as per the norms of the HAEI/ NEP recommendations.

3.9 Migration of students from one institution to other

It has been proposed for inter-institutional transfer of students with accumulation of the ABC. The HAEI may admit students either by holding its own admission test or use merit as criteria or by following any of the existing norms of the University. It is recommended to make institutional migration after 4th semester more convenient. HAEIs are at liberty to put in place

rules/ regulations relaxing/ modifying existing provisions of migration, providing more freedom and ease to students.

3.10 Minimum requirement for establishing colleges for agriculture and allied disciplines

The minimum requirements for establishing colleges for 13 agriculture and allied disciplines have been included in this report.

3.11 Making implementation of the recommendations of the Deans' Committee mandatory

A lot of efforts have been made to improve the quality of agricultural education to make it internationally competitive. Implementation of the recommendations of the Sixth Deans' Committee to be made mandatory for accreditation of academic programmes and academic institutions by the National Agricultural Education Accreditation Board (NAEAB).

Chapter 4

Restructuring of Undergraduate Programmes

4.1 Restructuring of UG Programs

The restructuring has been done based on the following NHEQF levels.

- Year 1, Certificate Course, NEP-NHEQF Level 4.5
- Year-2, Diploma Course, NEP-NHEQF Level 5.0
- Year 4, B.Sc. (Hons.)/ B. F.Sc.(Hons.)/ B. Tech. NEP-NHEQF Level 6.0

The restructured program for the undergraduate agriculture education with multiple entry and exit options is illustrated in Figure 4.1.

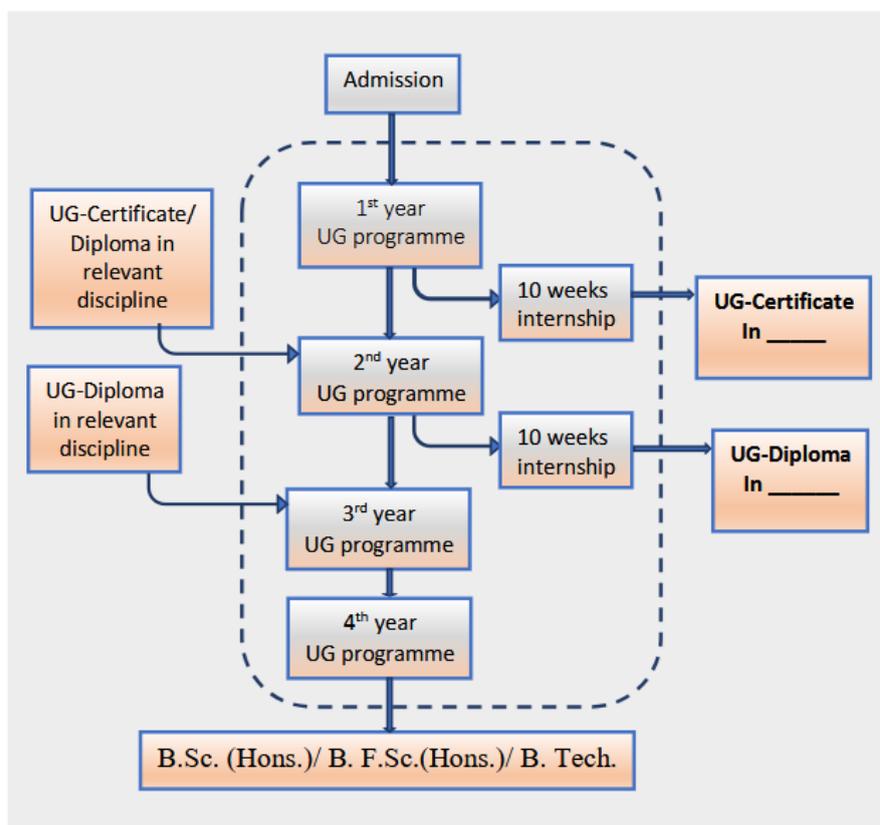


Fig. 4.1 Framework of Undergraduate Programmes

The eligibility for entry into the UG programmes will be + 2 Science; the students will be admitted as per norms of ICAR/ SAUs. The 1st year of the programme will be having the foundation, introductory and skill enhancement courses. The 2nd year will be having basic core courses with some more options for skill enhancement. The 3rd year of the programme will have advanced core courses. The 4th year programme will emphasize more on the

specialisation and elective courses as well as advanced skill enhancement through internship and research.

There will be exit options after 1st year and 2nd year for UG-Certificate and UG-Diploma. However, the students opting to exit with UG-Certificate or UG-Diploma will have to take up 10 weeks internship after the 1st year and 2nd year, respectively.

Table 4.1 shows the restructured undergraduate programs for the higher agricultural educational institutions (HAEIs), as follows.

Table 4.1 Types of the courses and learning outcomes for the restructured undergraduate programs for the HAEIs

Year	Types of courses	Learning outcome	Exit option
YEAR 1 <i>NHEQF Level 4.5</i>	Foundation courses, introductory courses and skills enhancement training/training in the chosen area, ability enhancement courses	The student will acquire the basic knowledge in respective disciplines and adequate skill in some selected areas, to enable him for employment/15student15neurs hip.	The student must complete 10 weeks of internship (10 credits) after 1 st year if exit with UG-Certificate is opted.
YEAR-2 <i>NHEQF Level 5</i>	Basic core courses and additional skill enhancement in chosen areas/ courses	The student will acquire the higher level knowledge in respective disciplines and adequate skill in some selected areas, to enable him for employment at middle level/ supervisory level or for entrepreneurship	The student must complete 10 weeks of internship (10 credits) after 2 nd year if exit with UG-Diploma is opted.
YEAR-3	Advanced core subjects and their practical applications	The student will have deeper understanding of the subjects and their major application areas	No exit after 3 rd year
YEAR-4 <i>NHEQF Level 6</i>	Specialization/ Elective courses and advanced skill enhancement through project and internship	The15studentt will acquire advanced knowledge and skill in different areas so as to meet the higher order requirements of the society and industry as well as other prospective employers. It will also enable the graduates to become a job provider rather than being a job seeker through establishment of enterprises in concerned fields.	UG degree in concerned discipline

4.2 Credit Hours Allocation

A total of **166-174** credit hours is recommended for the four years of UG programmes. The credit distributions for the different courses have been specified for individual disciplines and in disciplines like Agricultural Engineering and Food Technology, total number of credits and distribution of courses is slightly different due to the discipline related requirement.

Note:

- The credit hours mentioned in the table includes both theory and practical.
- The maximum credit allocation and the allocation for different types of courses for some disciplines such as Agricultural Engineering, Dairy Technology and Food Technology are different than other disciplines.
- Also, some minor deviations in the courses and credits are allowed across disciplines considering the specific nature of the courses.
- **The three year course curricula of all disciplines of agricultural and allied sciences do not cover the teaching of elective courses, that in fact qualify the students in specializing in a particular subject in which the student intends to do further studies. These courses have been presently listed under the 7th and 8th semesters (in IV year). Therefore, the sixth Deans' Committee is of the view that the option of B. Sc. (Hons.) with research may lead to deficiency of the knowledge and learning of the elective / specialized subjects needed for PG studies. For B. Tech. programmes, the framework prescribed by AICTE/ UGC may be applicable. Under such circumstances, the Committee recommends that the launching UG degree with research should be deferred for the time being. ICAR may consider about this aspect along with considering restructuring PG/ Ph.D. programmes. Also considering the professional nature of the courses, the exit after at the end of 3rd year (at the end of 6th semester) is not recommended.**
- Each class (contact hour) will be of 50 min duration and one practical will be of two contact hours.
- If the student has to take up any deficiency course(s), that has to be satisfactorily completed within the first year.

4.3 *Deeksharambh (Introduction- cum-foundation course)*

The goal of higher education is to nurture students by unfolding their hidden potentials to pursue the academic and professional studies in a diligent, honest and responsible manner by facilitating them to develop a sense of integrity with diverse faculties and build linkages with peers, society and community as a whole and lastly be proficient in earning livelihood independently along with sustaining society and nature.

A course entitled "Deeksharambh" (0+2) (Non-gradual) will be offered at the start of first semester for two weeks' duration. This will be a part of first semester for all purposes including the calculation of Net Instruction Days (NIDs).

The goal of '*Deeksharambh*' is to inculcate life skills, develop bonding with mentors, peers and seniors, familiarize with institutional academic framework and functioning, It must educate students to explore their potentials and understand the purpose of their life with reference to serving the community, nation and global society.

Often the incoming undergraduate students are influenced by their parents and relatives to join higher studies, without understanding their own interests and talents. Therefore, the very

purpose of initiating “*Deeksharambh*”: the induction cum foundation course is to acclimatize him/her with the new surroundings, develop bond with fellow students and teachers. It is the time when a student should become clear as to why he/she is going to study a particular discipline, or even it is time to quit and join another discipline of his/ her choice. They must develop sensitivity towards various issues of social relevance and imbibe human values to become responsible citizens.

Thus, ensuring a well-designed Induction cum foundation program by the institutions should be designed to become helpful to both teachers and students for setting the pace of productive teaching and learning experiences.

Four Pillars of “*Deeksharambh*”

- **Socializing:** meeting new students, senior students, Lectures by Eminent People.
- **Associating:** visits to university / college, visits to Dept./Branch/ Program of study & important places on campus, local area, city and so on;
- **Acclimatizing with** rules and regulations, student support system, etc.
- **Experiencing:** Subject lectures, study skills, small-group activities, physical activity, creative and performing arts, literary activities, universal human values, etc.

“*Deeksharambh*” will create a platform for students to

- Learn from each other’s life experiences,
- Help for cultural Integration of students from different backgrounds,
- Know about the operational framework of academic process in university
- Instilling life and social skills,
- Social Awareness, Ethics and Values, Team Work, Leadership, Creativity, etc.
- Identify the traditional values and indigenous cultures along with diverse potentialities both in indigenous and developed scenario.

There will be sessions by alumni, business leaders, outstanding achievers in related fields, people with inspiring life experiences as well as the University academic & research managers

Steps will be taken by the institutions to identify the strength and weakness of students (with remedial measures) and diverse potentialities and to enhance cultural Integration of students from different backgrounds.

4.4 Common courses

The following common courses have been proposed to be offered across the disciplines, which in addition to giving the students a broader view of agriculture and allied sectors, will enable them for better communication skills and personality development. Besides, this will also help them to look beyond the boundaries of their own subject/ discipline, which will help them for future collaboration with other sectors to face the next generation challenges from a holistic point of view.

- Farming based livelihood systems
- Entrepreneurship Development and Business Management
- Agriculture Marketing and Trade

- Communication Skills
- Personality Development
- Environmental Studies and Disaster Management
- Agricultural Informatics

In addition to the “Deeksharambh”, the courses as Physical Education, First Aid, and Yoga Practices, NCC and NSS have also been made compulsory for students for improving social awareness, ethics, moral values and health of the future generation.

4.5 New age courses

Courses like artificial intelligence, robotics, machine learning, etc. have been incorporated into the course curricula. Besides an array of elective courses have been included so that the student can get deeper knowledge and understanding in the subject of his interest. Emphasis has also been given to include the latest topics and subjects in both core and elective courses. Practical exercises and pedagogy are proposed to make the next generation more imaginative, innovative, ingenious, creative and competent.

4.6 Deficiency courses

If the student has to take up any deficiency course(s), it has to be completed within the first year.

4.7 Entrepreneurship development

Entrepreneurship is a key driver of the economy of a nation, which has been encouraged through NEP. Expectation is that an early orientation of the young minds towards skill enhancement and entrepreneurship will inculcate entrepreneurial mindset, allowing them to have first-hand experience of working with institutions, organizations, companies, industrial setup and investors so as to understand their dynamics in the real-world setting.

The restructured undergraduate curricula are designed to enable the students to take up entrepreneurship as a career path. As per NEP, the curricula in all the disciplines of Agricultural education have been refined and fine-tuned with intensive focus on choice-based skill enhancement programs.

Skill enhancement courses are included in different modes as follows.

- Skill enhancement courses in the 1st year and 2nd year as part of the course programmes
- Internship for exit programs after 1st year/ 2nd year
- Advanced skill enhancement through Student READY and/or in-plant training/ internship in 4th year

Internship can be seen as a mini capsule of intense learning for a student, a way to apply the theory into practice, expand their knowledge base and a platform to integrate all learnings of formal classroom setup.

Addition of new age courses related to Agriculture, Forestry, Fisheries, Agricultural Engineering, Community Science, Food Nutrition and Dietetics, etc., and incorporation of choice based online courses which can be taken up from NPTEL, moo KIT, edX, Coursera, SWAYAM or any other portal in open digital learning environment. Practical exercises and

teaching methodology are so designed to make the young generation more imaginative, innovative, ingenious, creative and competent.

The skill set acquired must make them proactive, pioneering, prospect oriented during their internship or industrial attachment to serve as apprentices in the relevant field and will empower them to grasp viable avenues of self-employment and entrepreneurship along with diversified career options in different facets of related domains.

4.7.1 Skill Enhancement Courses

The skill enhancement programmes will be choice based; student can choose the areas of skill enhancement from a basket of skill enhancement modules offered by the parent institution. The institutions will develop capabilities for offering such courses. Universities/HAEIs can also offer UGC skill courses as per resources /expertise available.

An institution is at liberty to (and in fact, it should) work in partnership with capable organizations/ companies/ NGOs/ progressive entrepreneurs/ farmers for running various skill enhancement programmes.

In the report, for each discipline the list of Skill Enhancement Courses (SEC) have been suggested. The University/ HAEIs may also formulate and offer courses in any other areas as identified by it, based on institutional expertise/ capabilities/ resources. In addition, the skill enhancement courses suggested by the UGC.

The evaluation of the skill enhancement programmes will be as per the evaluation criteria of courses with only practical. However, for the internship programmes, the evaluation will be done jointly by the host and parent organisations/ institutions.

4.7.2 Internship

The internship proposed under NEP have been an integral part of agricultural education (as proposed by Fifth Deans' Committee) under the broad category of Student READY programs. It includes various activities such as Experiential Learning/ Hands-On Training, Skill Development Training, Rural Agricultural Work Experience (RAW), In-Plant Training/ Industrial Attachment and Students' Projects. Therefore, in the recommended structure, the student READY is further strengthened as per NEP guidelines.

Those students who wish to exit with UG-certificate after one year, has to undergo 10 weeks of internship programme (10 credits) after 1st Year. Similarly, the students who wish to exit with UG-Diploma after second year, has to undergo 10 weeks of internship programme (10 credits) after 2nd Year. The goal of Internship at exit for UG-Certificate and UG-Diploma is to further strengthen skills in the chosen area/ subject.

Internship should be preferably arranged outside of the parent institution at any assigned organization/ industry/ research institution/ project or with a progressive farmer/ agri enterprise, etc.

HAEIs will ensure that the Internship program is aligned with the course that the student has chosen. It is recommended that each HAEI appoints one or more Coordinators for the internship programmes. The coordinator must plan/execute/ monitor internship programme implementation at the institution level.

4.7.3 Projects

For some disciplines, projects have been kept as an integral part of the course programme. This will enable the students to develop required competencies and skill in either research or entrepreneurship or potential employment avenues rather than having only mere qualifications, choose appropriate career in research or employment/ entrepreneurship,

discover his/ her interests, aptitudes and potentialities and maximise his/ her potentialities and self-confidence. It will also add to creativity and critical thinking of the students. This will also help the students gain research skills and be more innovative in planning, executing, reporting and presenting the things.

4.8 Study tour

There will be a study tour of 10-14 days' duration during the 7th semester of the UG programme. The students will preferably visit the leading industries/ enterprises/ institutions/ organisations and other places of academic interest outside the state (of location of the institution). This, in addition to exposing the students to the indigenous as well as the latest technologies in their related fields, will also help the students to know about the socio-economic-cultural variations within the country. The course will be of 0+2 credits, non-gradual.

4.9 Online courses

The students will have to take a minimum of 10 credits of online courses, which will comprise of one or more courses, as a partial requirement for the UG programme.

(As per UGC guideline, a 1 to 3 credit SWAYAM course is expected to be covered in 4-12 weeks' duration including the assessment component, in which it should be 40 hours for 3 credit courses to 80 hours for a 6 credit course for the learning from e-content, reading references material, discussion forum posting and assignment.)

The online courses can be from any field such as Basic Sciences, Humanities, Psychology, Anthropology, Economics, Engineering, Business Management, Languages including foreign language, Communication skills/ Music, etc. and can be taken from NPTEL, mooKIT, edX, Coursera, SWAYAM or any other portal.

The objective is to allow the students to groom their passion or strengthen their knowledge and competency in any field beyond prescribed courses.

The courses will be non-gradual as separate certificates would be issued by institutes offering the courses. These can be taken any time during the duration of UG program, but preferably during the 3rd and 4th years.

The University/ institute will keep a record of such courses registered and completed by each student and will indicate the title of the (successfully completed) courses in final transcript issued to the student.

The requirement of credits for online courses for B. Tech. programmes has been different due to the specific need of the disciplines.

4.10 Elective courses

The institutions will offer a basket of Elective courses to be offered to the students. The students will have the freedom to choose a subject among these courses. The institutions should develop capabilities to offer maximum of the Elective courses proposed in this report. The institutions will also have the liberty to develop new Elective courses as per local needs and available expertise. The elective courses can be offered from other disciplines in a Universality/HAls.

4.11 Imparting Traditional Knowledge, Values and Ethics

Due emphasis has been given for imbibing the traditional knowledge, values and ethics among the students through different courses like the *Deeksharambh*, NCC/ NSS/ NSO. It is proposed the 'Study tour' shall be conducted across the country to be aware about the socio-cultural-economic status of the people of the country and develop respect for their values and ethics.

4.12 Light but tight educational programme

As per the norms of the NEP 2020, the programme has been made light but tight for the students. The total credit hours have been kept at 175 considering the specific need of the professional courses. At the same time, the students have been given the option of the skill development courses, internship, online courses, etc., which will make their learning experience pleasurable and learning more efficient.

4.13 Moderation of courses at institution level

The following flexibility is allowed to the institutions for offering the courses.

- A. Maximum 30% modification in the syllabus for any individual subject. It is recommended the HAEI should consider updating the course curricula around 5% every year. That would enable addition of new contents replacing obsolete/ old contents in the courses.
- B. Formulation /addition/ change of Skill Enhancement modules as per needs/ facilities available
- C. Interchange of courses in between semesters within a year (but no change of course shall be normally allowed in between years).
- D. Change of maximum two core courses (If any course is removed from the list of core course, it should be kept as elective), However, the total credit hours should not be lower than the prescribed.
- E. Inclusion of any number of courses as Electives and freedom to offer the Elective courses.
- F. Modification/ change of credit hours for any four courses (however, total credit hours should not differ by more than two)
- G. In case the skill enhancement/ internship programs are conducted in collaboration with industry/ other organizations/ agencies, the students may be expected to remain out of the campus for a certain period within the semester. In that situation, the timetable should be so adjusted for the remaining part of the net instruction days (NIDs) of the corresponding semester, that each credit has at least 15 contact hours.

4.14 Central Assistance for strengthening higher agricultural education

The central Assistance for strengthening higher agricultural education, as proposed by the Fifth Deans' Committee, may be continued.

4.15 Admission Criteria

The eligibility and mode of admission for entry into the UG programmes will be as per the prevailing ICAR/SAU norms.

Agriculture universities/ colleges and other general universities offering agricultural disciplines, will fall under the umbrella of ICAR, as PSSB for agriculture education, as mandated by NEP.

Institutions are at liberty to assess their student intake capacity, and announce the number of seats available in the first semester, and for lateral entries at 3rd semester and 5th semester.

The lateral entry at 3rd semester will be for the candidates having UG-certificate or those who have completed Diploma (3 years course after 10th) in polytechnics. The lateral entry in 5th semester will be for candidates who have completed UG-Diploma.

There cannot be guaranteed promotion to next level. Institutions are at liberty to make their own decisions on the matter of seats and admissions in 3rd and 5th semesters.

4.16 Provision of lateral entry for Diploma holders from polytechnics

Candidates having a Diploma from polytechnics (after completion of 3 years course after 10th in related disciplines) will be entitled to take admission in the 2nd year (3rd semester) program. The HAEI may admit students either by holding its own admission test or use merit as criteria or by following any of the existing norms of the University.

4.17 Migration from one University to other

The UG-Certificate/ UG-Diploma passed candidate from a HAEI will be eligible for admission into any agricultural university in the country at appropriate level, provided the admitting university has provision of seats to admit them.

It is recommended to make institutional migration after 4th semester more convenient. HAEIs are at liberty to put in place rules/ regulations relaxing/ modifying existing provisions of migration, providing more freedom and ease to students.

Provided further, any such rule/ regulation that is notified by UGC regarding changes in admission criteria, migration, etc., these notifications will be considered/ examined by ICAR and re-notified to make them applicable to agricultural education falling under its domain.

4.18 Exit Option

There will be three exits during the restructured UG programme.

Exit after 1st year: A student may opt to exit after the 1st year of UG programme. However, he/ she has to complete 10 weeks of internship (10 credits) to be eligible for being awarded UG-Certificate degree. (The students going to the higher level need not take 10 weeks internship at this stage.)

Exit after 2nd year: A student may opt to exit after the 2nd year of UG programme. However, he/ she has to complete 10 weeks of internship (10 credits) to be eligible for being awarded UG-Certificate degree. (The students going to the higher level need not take 10 weeks internship at this stage.)

Exit after 4-years programme leading to B.Sc. (Hons.)/ B.F.Sc. (Hons.)/ B. Tech. degree

4.19 Maximum residential period

Students who exit with a UG- Certificate or UG- Diploma are permitted to re-enter within three years and complete the degree programme.

Students may be permitted to take a break from the study during the period of study after completion on one year of the UG programme, but the total duration for completing the UG programme shall not exceed 7 years.

4.20 Examination and Evaluation system

There will be a uniform system of the evaluation and grading to be followed with Grade point average (GPA) system. The following pattern of examination is recommended.

Table 4.3 Evaluation system

	External theory	Internal theory (Mid-term)	Quiz/ progressive assessment	Final Practical
For courses having both theory and practical components	40%	20 %	20%	20%
For courses with theory only	50%	30%	20%	--
Courses with practical only	--	30% (Practical)	20%	50% (Internal)

For the external theory examinations, the question paper will be obtained from external experts. The HODs of the respective departments will ensure due coverage of the syllabus with the provision of moderation, if necessary. Paper evaluation to be done by a faculty other than the course instructor(s).

Internal practical examination to be conducted by the course instructor and one faculty nominated by the HOD of the concerned department.

As mentioned earlier, the evaluation of the Skill Enhancement courses will be done as courses with practical only.

Usually for any subject, there will be three quizzes within the semester. Out of three, best 2 quiz marks will be considered. The assessment of the students through quizzes should focus on their critical thinking and creativity rather than rote reading.

The quiz and progressive assessment can also be considered in form of group assignments (which should encourage creativity, critical thinking and problem solving attitude).

The evaluation of internship will be done both by the parent institute and the host industry/organisation. It should be 50% weightage for each. The student shall submit a report to the parent institute and present the learnings before the other students and faculty after the internship programme. The format of evaluation may be developed by the parent institute.

The online/MOOC courses, successfully completed by the student, will be indicated in the transcript with 'Satisfactory' remark.

When students take deficiency course(s), they will be assessed as 'Satisfactory' or 'Unsatisfactory' without any grade points.

The evaluation will be done on a 10 point scale.

10 point = 100 marks

The per cent of marks in a subject will be divided by 10 to obtain the grade point.

The grade point average for a semester will be calculated as follows.

$$GPA = \frac{\sum (Grade\ point \times credit\ hours)_{in\ one\ semester}}{Total\ credit\ hours\ in\ the\ semester}$$

The Cumulative grade point earned at any stage of the course will be calculated as cumulative grade point average (CGPA) as follows.

$$CGPA = \frac{\sum (Grade\ point \times credit\ hours)_{until\ last\ semester}}{Total\ credit\ hours\ until\ last\ semester}$$

If a student passes in a subject in a second attempt, for calculation of CGPA, the grade point for the subject in the second attempt will only be considered. The final CGPA will be named as overall grade point average (OGPA), which will be mentioned in the final transcript of the students.

4.21 Award of Divisions

The award of the divisions will be as per table given follows.

Award of the divisions

OGPA	Division
5.000-5.999	Pass
6.0000-6.999	II division
7.000—7.999	I Division
8.000 and above	1 st division and distinction

4.22 Uniformity in Nomenclature of Degrees

To ensure hassle free movement of students across the country, it is important that nomenclature of degrees awarded is same, across all HAEIs. The nomenclatures will be as follows.

a. UG-Certificate with mention of discipline

e.g. UG-Certificate in Agriculture, UG-Certificate in Horticulture, UG-Certificate in Agricultural Engineering

Note: If any institution is at present offering any certificate course of less than a year period, it may continue to do so, but this certificate course will not be considered equal to UG-Certificate.

b. UG-Diploma with mention of discipline

e.g. UG-Diploma in Agriculture, UG-Diploma in Horticulture, UG-Diploma in Agricultural Engineering

Note: If any institution is at present offering any Diploma course of less than two years' period after +2 Science, it may continue to do so, but this diploma course will not be considered equal to UG-Diploma.

The nomenclature of undergraduate degrees will be per the recommendations of the 5th Deans' Committee as follows.

B. Sc. (Hons.)/ B.F.Sc. (Hons.)/ B. Tech. followed by discipline

e.g. B.Sc.(Hons.) Agriculture/ B.F.Sc (Hons.)/ B. Tech. (Agricultural Engineering)

The nomenclature of degrees may change in case any such revision is suggested by the UGC.

4.23 Increasing Gross Enrolment Ratio (GER)

Keeping in view the NEP call for increasing GER, it is recommended that provision is made by institutions to launch stand-alone UG-Certificate and/ or UG-Diploma courses in specific subjects/ disciplines. The entrance examinations for such programs will be separate. The students completing the UG-Certificate will have to appear separate entrance test for continuing to higher level. Similarly, the students completing the UG-Diploma will have to appear separate entrance test for continuing to higher level.

4.24 Academic Bank of Credits (ABC)

As per NEP guideline, the HAEI will create an Academic Bank of Credits (ABC) of each student and recognise the ABC of a student as per the norms of the HAEI/ NEP recommendations.

4.25 Making implementation of the recommendations of the Deans' Committee mandatory

A lot of efforts have been made to improve the quality of agricultural education to make it internationally competitive. Implementation of the recommendations of the Sixth Deans' Committee to be made mandatory for accreditation of academic programmes and academic institutions by the National Agricultural Education Accreditation Board (NAEAB).

COMMON COURSES

Sr. No.	Title of common course	Credit
1	Deeksharambh (Induction-cum-Foundation Programme)	2*(0+2)
2	Farming based Livelihood Systems	3(2+1)
3	Entrepreneurship Development and Business Management	3(2+1)
4	Agriculture Marketing and Trade	3(2+1)
5	Agricultural Informatics & Artificial Intelligence (AI)	3(2+1)
6	Environmental studies and disaster management	3(2+1)
7	Communication Skills	2(1+1)
8	Personality Development	2(1+1)
9	Physical Education, First Aid and Yoga Practices	2(0+2)
10	NCC- I (National Cadet Corps-I)	1(0+1)
11	NSS- I (National Service scheme-I)	1(0+1)
12	NCC- II (National Cadet Corps-II)	1(0+1)
13	NSS- II (National Service scheme-II)	1(0+1)
14	NCC- III (National Cadet Corps-III)	1*(0+1)
15	NSS- III (National Service scheme-III)	1*(0+1)
16	NCC- IV (National Cadet Corps-IV)	1*(0+1)
17	NSS- IV (National Service scheme-IV)	1*(0+1)

*** Non Gradial**

Chapter-5

Semester Wise Courses and Credits Distributions

FACULTY OF AGRICULTURAL ENGINEERING				
Undergraduate Course Curriculum				
Sr. No.	Course Number	Course Title	Credit Hours	Total Credit Hours
First Year				
I Semester				
1	FC - I	Deeksharambh (Induction cum Foundation courses)	2 (0+2*)	20 (11+9) + 5* Non Gradial
2	MDC - IV	Crop Production and Protection Technologies	4 (3+1)	
3	CAE1.3	Introduction to Agricultural Engineering	4 (3+1)	
4	SWCE1.4	Surveying and Levelling	3 (1+2)	
5	FMPE1.5	Engineering Drawing	2 (0+2)	
6	REE1.6	Basic Electrical Gadgets and Instruments	3 (2+1)	
7	VAC - II	Agricultural Informatics and Artificial Intelligence	3 (2+1)	
8	AEC-V AEC-VI	National Service Scheme (NSS- I) / OR National Cadet Corps (NCC- I)	1 (0+1)	
9	AS1.9	Introduction to Engineering Mathematics	3 (3*+0)	
II Semester				
1	FMPE2.1	Workshop Technology and Practice	2(0+2)	21 (5+16)
2	@	Skill Enhancement course (1-24)	4(0+4)	
3	@	Skill Enhancement course (1-24)	4(0+4)	
4	AEC - IV	Computer Programming and Data Structures	2(0+2)	
5	MDC - I	Farming Based Livelihood Systems	3(2+1)	
6	VAC - I	Environmental Studies and Disaster Management	3(2+1)	
7	AEC - I	Communication Skills	2(1+1)	
8	AEC - VII AEC - VIII	National Service Scheme (NSS- II) / OR National Cadet Corps (NCC- II)	1(0+1)	
Post-II Semester				
9	Int2.9	Internship (for 10 weeks, only for exit option for award of UG-Certificate)	10 (0+10)	
Second Year				
III Semester				
1	AS3.1	Engineering Mathematics- I	3 (3+0)	26 (17+9) +1 Non Gradial
2	AS3.2	Engineering Physics	3 (2+1)	
3	AS3.3	Engineering Chemistry	3 (2+1)	
4	FMPE3.4	Engineering Mechanics	3 (2+1)	
5	SWCE3.5	Watershed Hydrology	3 (2+1)	
6	IDE3.6	Fluid Mechanics and Open Channel Hydraulics	3 (2+1)	

7	PFE3.7	Engineering Properties of Agricultural Produce and Food Science	3 (2+1)	
8	FMPE3.8	Farm Machinery & Equipment - I	3 (2+1)	
9	AEC - III	Physical Education, First Aid, Yoga Practice and Meditation	2 (0+2)	
10	AEC - IX AEC - X	National Service Scheme (NSS- III) / OR National Cadet Corps (NCC- III)	1*(0+1)	
IV Semester				
1	AS4.1	Engineering Mathematics-II	3 (3+0)	24 (17+7) +1 Non Gradial
2	SWCE4.2	Theory of Structures	2 (1+1)	
3	SWCE4.3	Building Construction & Cost Estimation	2 (2+0)	
4	SWCE4.4	Soil Mechanics	2 (1+1)	
5	SWCE4.5	Soil and Water Conservation Engineering	3 (2+1)	
6	FMPE4.6	Farm Machinery & Equipment II	3 (2+1)	
7	REE4.7	Renewable Energy Sources	3 (2+1)	
8	PFE4.8	Post-harvest Engineering of Cereals, Pulses and Oilseeds	3 (2+1)	
9	MDC - II	Entrepreneurship Development and Business Management	3 (2+1)	
10	AEC - XI AEC - XII	National Service Scheme (NSS- IV) / OR National Cadet Corps (NCC- IV)	1*(0+1)	
Post-IV Semester				
11	Int4.10	Internship (for 10 weeks, only for exit option for award of UG-Diploma)	10 (0+10)	
Third Year				
V semester				
1	SWCE5.1	Strength of Materials	2 (1+1)	25 (15+10)
2	FMPE5.2	Theory of Machines	2 (2+0)	
3	PFE5.3	Thermodynamics and Heat Transfer	3 (3+0)	
4	FMPE5.4	Tractor & Automotive Engines	3 (2+1)	
5	IDE5.5	Irrigation and Drainage Engineering	4 (3+1)	
6	PFE5.6	Food and Dairy Engineering	4 (3+1)	
7	AEC-II	Personality Development	2 (1+1)	
8	CAE5.8	Seminar	1 (0+1)	
9	Int5.9	In-plant Training/ Research Internship - I	4 (0+4)	
VI Semester				
1	FMPE6.1	Tractor Systems & Controls	3 (2+1)	22 (14+8)
2	IDE6.2	Groundwater, Wells and Pumps	3 (2+1)	
3	CSE6.3	Sensors, AI and Robotics in Agriculture	3 (2+1)	
4	PFE6.4	Agricultural Structures & Environment Control	3 (2+1)	
5	REE6.5	Bioenergy Systems: Design and Applications	3 (2+1)	
6	PFE6.6	Refrigeration and Air-conditioning	3 (2+1)	
8	PFE6.7	Post-harvest Engineering of Horticultural Crops	2 (1+1)	
9	REE6.8	Waste Utilization and Management	2 (1+1)	
Fourth Year				
VII semester				
1	SEC7.1	Project- I	3 (0+3)	24 (10+14)

2	FMPE7.2	Engineering Graphics and Design	2 (0+2)	+ 2 non-gradual
3	PFE7.3	Food Quality and Safety	3 (2+1)	
4	SWCE7.4	Watershed Planning and Management	3 (2+1)	
5	IDE7.5	Sprinkler & Micro Irrigation Systems	2 (1+1)	
6	FMPE7.6	Machine Design	2 (2+0)	
7	REE7.7	Electrical Machines	3 (2+1)	
8	AS7.8	Agricultural Statistics and Data Analysis	2 (1+1)	
9	Int7.9	In-plant Training/ Research Internship - II	4 (0+4)	
10	ST7.10	Study tour	2 (0+2*)	
VIII semester				
1	SEC8.1	Project -II	4 (0+4)	13 (6+7)
2		Elective- I	3 (2+1)	
3		Elective- II	3 (2+1)	
4		Elective- III	3 (2+1)	
			TOTAL	175 (95+80)
On-line courses			6	6*
			Grand Total	175+13*
8th Semester Elective Courses				
1	FMPE8.3	Mechanics of Tillage and Traction	3 (2+1)	
2	FMPE8.4	Farm Machinery Design and Production	3 (2+1)	
3	FMPE8.5	Tractor Design and Testing	3 (2+1)	
4	FMPE8.6	Hydraulic Drives and Controls	3 (2+1)	
5	FMPE8.7	Human Engineering and Safety	3 (2+1)	
6	FMPE8.8	Precision Agriculture and System Management	3 (2+1)	
7	REE8.9	Photovoltaic Technology and Systems	3 (2+1)	
8	REE8.10	Wind Power Technology and Systems	3 (2+1)	
9	REE8.11	Waste and By-products Utilization	3 (2+1)	
10	SWCE8.12	Floods and Control Measures	3 (2+1)	
11	SWCE8.13	Remote Sensing and GIS Applications	3 (2+1)	
12	SWCE8.14	Information Technology for Land and Water Management	3 (2+1)	
13	SWCE8.15	Wasteland Development	3 (2+1)	
14	IDE8.16	Minor Irrigation and Command Area Development	3 (2+1)	
15	IDE8.17	Management of Canal Irrigation System	3 (2+1)	
16	IDE8.18	Water Quality and Management Measures	3 (2+1)	
17	IDE8.19	Landscape Irrigation Design and Management	3 (2+1)	
18	AS8.20	Application of Plastics in Agriculture	3 (2+1)	
19	AS8.21	Precision Farming Techniques for Protected Cultivation	3 (2+1)	
20	PFE8.22	Environmental Engineering	3 (2+1)	

21	PFE8.23	Development of Processed Food Products	3 (2+1)	
22	PFE8.24	Food Packaging Technology	3 (2+1)	
23	PFE8.25	Food Plant and Equipment Design	3 (2+1)	
24	PFE8.26	Emerging Technologies in Food Processing	3 (3+0)	
25	PFE8.27	Processing of Livestock, Fish and Marine Products	3 (2+1)	
26	PFE8.28	Food Business Management and Entrepreneurship Development	3 (3+0)	
27	CSE8.29	MATLAB Programming	3 (1+2)	
28	CSE8.30	Python Programming	3 (1+2)	
29	CSE8.31	Artificial Intelligence	3 (2+1)	
30	CSE8.32	Advances in Automation and Robotics in Agriculture	3 (2+1)	
31	CSE8.33	Machine Learning	3 (2+1)	
32	AS8.34	Operations Research	3 (3+0)	
33	FMPE8.35	Mechatronics	3 (2+1)	
34	PFE8.36	Natural Fibers: Extraction & Properties	3 (2+1)	
35	PFE8.37	Natural Fiber Applications in Agriculture	3 (2+1)	
36	PFE8.38	Processing of Natural Fibers	3 (2+1)	
37	MDC-III	Agricultural Marketing and Trade	3 (2+1)	
Skill Enhancement Course Modules				
1	SEC1	Operation and maintenance of farm machinery	4 (0+4)	
2	SEC2	Repair and maintenance of tractors and power tillers	4 (0+4)	
3	SEC3	Management of agricultural machinery custom hiring and maintenance facilities	4 (0+4)	
4	SEC4	Fabrication, operation and maintenance of renewable energy devices	4 (0+4)	
5	SEC5	Operation and maintenance of drones used for agricultural applications	4 (0+4)	
6	SEC6	Machine vision, sensors and sensors architecture	4 (0+4)	
7	SEC7	Design of solar PV system using softwares	4 (0+4)	
8	SEC8	Installation and maintenance of on-grid and off-grid solar systems	4 (0+4)	
9	SEC9	Design and maintenance of agri-voltaic systems	4 (0+4)	
10	SEC10	Valorization of agri-biomass and organic waste	4 (0+4)	
11	SEC11	Energy audit, energy conservation and energy efficiency	4 (0+4)	
12	SEC12	Repair and maintenance of pumps and irrigation systems	4 (0+4)	
13	SEC13	Installation and maintenance of micro-irrigation systems	4 (0+4)	
14	SEC14	Application of remote sensing and GIS for agricultural water management	4 (0+4)	
15	SEC15	Operation and maintenance of hydro-meteorological instruments	4 (0+4)	

16	SEC16	Geophysical survey and investigations for groundwater exploration and installation of tube well/ bore well	4 (0+4)	
17	SEC17	Installation and maintenance of roof top rain water harvesting systems	4 (0+4)	
18	SEC18	Operation and maintenance of soil conservation structures	4 (0+4)	
19	SEC19	Construction, management and maintenance of protected cultivation structures	4 (0+4)	
20	SEC20	Agro processing methods, equipment operation and maintenance	4 (0+4)	
21	SEC21	Operation and management of multi-commodity agro-processing centre	4 (0+4)	
22	SEC22	Primary processing and value addition and cold chain logistics	4 (0+4)	
23	SEC23	Food grain godown and warehouse management	4 (0+4)	
24	SEC24	Post-harvest value chain management including logistics	4 (0+4)	

* **non-gradual**

@ as per the module opted /offered

Chapter-6

Department wise Courses

Course Code	Course title	Credit Hours	Total
Farm Machinery and Power Engineering			
FMPE1.5	Engineering Drawing	2 (0+2)	25 (14+11)
FMPE2.1	Workshop Technology and Practice	2 (0+2)	
FMPE3.4	Engineering Mechanics	3 (2+1)	
FMPE3.8	Farm Machinery & Equipment - I	3 (2+1)	
FMPE4.6	Farm Machinery & Equipment II	3 (2+1)	
FMPE5.2	Theory of Machines	2 (2+0)	
FMPE5.4	Tractor & Automotive Engines	3 (2+1)	
FMPE6.1	Tractor Systems & Controls	3 (2+1)	
FMPE7.2	Engineering Graphics and Design	2 (0+2)	
FMPE7.6	Machine Design	2 (2+0)	
Irrigation and Drainage Engineering			
IDE3.6	Fluid Mechanics and Open Channel Hydraulics	3 (2+1)	12 (8+4)
IDE5.5	Irrigation and Drainage Engineering	4 (3+1)	
IDE6.2	Groundwater, Wells and Pumps	3 (2+1)	
IDE7.5	Sprinkler & Micro Irrigation Systems	2 (1+1)	
Soil And Water Conservation Engineering			
SWCE1.4	Surveying and Levelling	3 (1+2)	20 (12+8)
SWCE3.5	Watershed Hydrology	3 (2+1)	
SWCE4.2	Theory of Structures	2 (1+1)	
SWCE4.3	Building Construction & Cost Estimation	2 (2+0)	
SWCE4.4	Soil Mechanics	2 (1+1)	
SWCE4.5	Soil and Water Conservation Engineering	3 (2+1)	
SWCE5.1	Strength of Materials	2 (1+1)	
SWCE7.4	Watershed Planning and Management	3 (2+1)	
Process and Food Engineering			
PFE3.7	Engineering Properties of Agricultural Produce and Food Science	3 (2+1)	24 (17+7)
PFE4.8	Post-harvest Engineering of Cereals, Pulses and Oilseeds	3 (2+1)	
PFE5.3	Thermodynamics and Heat Transfer	3 (3+0)	
PFE5.6	Food and Dairy Engineering	4 (3+1)	
PFE6.4	Agricultural Structures & Environment Control	3 (2+1)	
PFE6.6	Refrigeration and Air-conditioning	3 (2+1)	
PFE6.7	Post-harvest Engineering of Horticultural Crops	2 (1+1)	
PFE7.3	Food Quality and Safety	3 (2+1)	
Renewable Energy Engineering			

REE1.6	Basic Electrical Gadgets and Instruments	3 (2+1)	14(9+5)
REE4.7	Renewable Energy Sources	3 (2+1)	
REE6.5	Bioenergy Systems: Design and Applications	3 (2+1)	
REE6.8	Waste Utilization and Management	2 (1+1)	
REE7.7	Electrical Machines	3 (2+1)	
Allied Science			
AS1.9	Introduction to Engineering Mathematics	3(3*+0)	17(13+4) + *Non Gradial 3 (3+0)
AS3.1	Engineering Mathematics- I	3 (3+0)	
AS3.2	Engineering Physics	3 (2+1)	
AS3.3	Engineering Chemistry	3 (2+1)	
AS4.1	Engineering Mathematics-II	3 (3+0)	
CSE6.3	Sensors, AI and Robotics in Agriculture	3 (2+1)	
AS7.8	Agricultural Statistics and Data Analysis	2 (1+1)	
MDC-I	Farming Based Livelihood Systems	3 (2+1)	10 (7+3)
MDC - II	Entrepreneurship Development and Business Management	3 (2+1)	
MDC - IV	Crop Production and Protection Technologies	4 (3+1)	
MDC-III	Agricultural Marketing and Trade	3 (2+1)	3 (2+1) (Elective)
VAC - I	Environmental Studies and Disaster Management	3 (2+1)	6 (4+2)
VAC - II	Agricultural Informatics and Artificial Intelligence	3 (2+1)	
AEC-I	Communication Skills	2 (1+1)	6 (2+4)
AEC - II	Personality Development	2 (1+1)	
AEC - IV	Computer Programming and Data Structures	2 (0+2)	
Common Agricultural Engineering			
CAE1.3	Introduction to Agricultural Engineering	4 (3+1)	5 (3+2)
CAE5.8	Seminar	1 (0+1)	
In-plant Training / Internship			
Int2.9	Internship (for 10 weeks, only for exit option for award of UG-Certificate)	10(0+10)	10 (0+10)
Int4.10	Internship (for 10 weeks, only for exit option for award of UG-Diploma)	10(0+10)	10 (0+10)
Int5.9	In-plant Training/ Research Internship - I	4 (0+4)	4 (0+4)
Int7.9	In-plant Training/ Research Internship - II	4 (0+4)	4 (0+4)
Skill Enhancement Courses / Projects			
As per list- α	Skill Enhancement Courses [Any Two of 4(0+4) from list- α]	8(0+8)	8 (0+8)
SEC7.1	Project- I	3(0+3)	7 (0+7)
SEC8.1	Project -II	4(0+4)	
Students' Welfare			
FC 1.1	Deeksharambh	2(0+2*)	
AEC-III	Physical Education, First Aid and Yoga Practices	2(0+2)	2(0+2)
AEC-V	National Service Scheme (NSS- I)	1(0+1)	1(0+1)
AEC-VI	National Cadet Corps (NCC- I)		
AEC-VII	National Service Scheme (NSS- II)	1(0+1)	1(0+1)
AEC-VIII	National Cadet Corps (NCC- II)		
AEC-IX	National Service Scheme (NSS- III)	1*(0+1)	1*(0+1) Non Gradial
AEC-X	National Cadet Corps (NCC- III)		
AEC-XI	National Service Scheme (NSS- IV)	1*(0+1)	1*(0+1) Non Gradial
AEC-XII	National Cadet Corps (NCC- IV)		

ST7.10	Study Tour	2*(0+2)	2*(0+2) Non Gradial
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Chapter-7

Semester Wise Courses and Lecture/Practicals planning

FACULTY OF AGRICULTURAL ENGINEERING				
Undergraduate Course Curriculum				
Sr. No.	Course Number	Course Title	Credit Hours	Total Credit Hours
First Year				
I Semester				
1	FC-I	Deeksharambh (Induction cum Foundation course)	2 (0+2*)	20 (11+9) + 5 Non Gradial
2	MDC - IV	Crop Production and Protection Technologies	4 (3+1)	
3	CAE1.3	Introduction to Agricultural Engineering	4 (3+1)	
4	SWCE1.4	Surveying and Levelling	3 (1+2)	
5	FMPE1.5	Engineering Drawing	2 (0+2)	
6	REE1.6	Basic Electrical Gadgets and Instruments	3 (2+1)	
7	VAC - II	Agricultural Informatics and Artificial Intelligence	3 (2+1)	
8	AEC-V OR AEC-VI	National Service Scheme (NSS- I) OR National cadet corps (NCC- I)	1 (0+1)	
9	AS1.9	Introduction to Engineering Mathematics	3 (3*+0)	

SEMESTER – 1

Sr. No.	Course Name	Course No.	Credit	L	P	T
1	Deeksharambh (Induction-cum-Foundation Course)	FC-I	0+2*(NG)	--	2	2

Course Content:

The activities to be taken under “Deeksharambh”, in addition to giving a broad view and application areas of the subject of study, also will aim at creating a platform for

- Helping students from different backgrounds for cultural Integration
- Knowing about the operational framework of academic process in University
- Instilling life and social skills, leadership qualities, team working spirit
- Developing social awareness, ethics and values, creativity
- Helping students to identify the traditional values and indigenous cultures along with diverse potentialities both in indigenous and developed scenario.

The details of activities/schedules will be decided by the parent universities. The structures shall include, but not restricted to:

- i. Discussions on operational framework of academic process in university, as well as interactions with academic & research managers of the University
- ii. Creating awareness on the subject of study and the traditional values and indigenous cultures along with diverse potentialities both in indigenous and developed scenario
- iii. Interaction with alumni, business leaders, perspective employers, outstanding achievers in related fields, and people with inspiring life experiences
- iv. Group activities to identify the strength and weakness of students (with expert advice for their improvement) as well as to create a platform for students to learn from each other's life experiences
- v. Field visits to related fields/establishments
- vi. Sessions on personality development (instilling life and social skills, social awareness, ethics and values, team work, leadership, etc.) and communication skills

SEMESTER – 1

Sr. No.	Course Name	Course No.	Credit	L	P	T
2	Crop Production and Protection Technologies	MDC-IV	4(3+1)	3	1	4

Objective

To enable the students to have basic idea on crop production and protection practices to understand the domain of agricultural sciences and to have an idea of the different types of machineries/ equipment that can be adopted for these operations.

Theory

Introduction and scope of agronomy; Classification of crops; Effect of different weather parameters on crop growth and development; Principles of tillage, tith and its characteristics; Crop seasons; Time and method of sowing of major field crops, seed rate for important crops; Methods and time of application of manures and fertilizers, fertigation; Basic principles of natural farming, organic farming and sustainable agriculture Soil-water-plant relationship, crop

coefficients, water requirement of crops and critical stages for irrigation; Weeds and their management in crops; Crop rotation, cropping systems, cropping scheme, relay cropping, mixed cropping and intercropping

Soil forming processes; Classification and composition of soil, soil taxonomy orders; Important soil physical properties and their importance; soil particle distribution; soil inorganic colloids– their composition, properties and origin of charge; ion exchange in soil and nutrient availability; soil organic matter– its composition and decomposition, effect on soil fertility; Soil reaction – acidic, saline and sodic soils; Quality of irrigation water Essential plants nutrients– their functions and deficiency symptoms in plants; Important inorganic fertilizers and their reactions in soils; Gypsum requirement for reclamation of sodic soils and neutralizing RSC; Liquid fertilizers and their solubility and compatibility

Types of horticultural crops; Sowing and planting times and methods; Seed rate and seed treatment for vegetable crops; Macro and micro propagation methods; Types of plant growing structures; Pruning and training; Water requirements and critical stages; Management of orchard; Major pests and diseases of horticultural and agriculture crops and their management

Practical

Identification of crops and their varieties, seeds and weeds; Study of different fertilizer application methods and weed control methods; Judging the maturity time for harvesting of crop; Study of seed viability and germination test; Identification of rocks and minerals; Examination of soil profile in the field; Determination of bulk density; particle density and porosity of soil; Determination of organic carbon of soil; Identification of nutrient deficiency symptoms of crops in the field; Determination of gypsum requirement of sodic soils; Identification and description of important fruits, flowers and vegetables crops; Study of different garden tools; Preparation of nursery bed; Practices of pruning and training in some important fruit crops; Study of cultural operations for vegetable crops (sowing, fertilizer application, mulching, irrigation and weed control); Seed extraction techniques; Visit to commercial greenhouse/ polyhouse

Planning of lectures		
SN	Topics to be covered in lecture	Proposed No. of Lecture
1	Introduction and scope of agronomy	2
2	Classification of crops	2
3	Effect of different weather parameters on crop growth and development	2
4	Principles of tillage, tith and its characteristics; Crop seasons	2
5	Time and method of sowing of major field crops, seed rate for important crops	2
6	Methods and time of application of manures and fertilizers, fertigation	2
7	Basic principles of natural farming, organic farming and sustainable agriculture	2
8	Soil-water-plant relationship, crop coefficients, water requirement of crops and critical stages for irrigation	2
9	Weeds and their management in crops	2
10	Crop rotation, cropping systems, cropping scheme, relay cropping, mixed cropping and intercropping	2
11	Soil forming processes	2
12	Classification and composition of soil, soil taxonomy orders	2

13	Important soil physical properties and their importance; soil particle distribution	2
14	soil inorganic colloids– their composition, properties and origin of charge; ion exchange in soil and nutrient availability	2
15	soil organic matter– its composition and decomposition, effect on soil fertility	2
16	Soil reaction – acidic, saline and sodic soils, quality of irrigation water	2
17	Essential plants nutrients- their functions and deficiency symptoms in plants	2
18	Important inorganic fertilizers and their reactions in soils	2
19	Gypsum requirement for reclamation of sodic soils and neutralizing RSC	2
20	Liquid fertilizers and their solubility and compatibility	2
21	Types of horticultural crops	1
22	Sowing and planting times and methods	1
23	Seed rate and seed treatment for vegetable crops	2
24	Macro and micro propagation methods	1
25	Types of plant growing structures; Pruning and training	2
26	Water requirements and critical stages	1
27	Management of orchard; Major pests and diseases of horticultural and agriculture crops and their management	3
	Total	51

Practical

Practical		
Sr.No.	Topic	No. of Practical's
1	Identification of crops and their varieties, seeds, manure, fertilizers and weeds	1
2	Fertilizer application methods, Different weed control methods	1
3	Judging the maturity time for harvesting of crop	1
4	Study of seed viability and germination test	1
5	Identification of rocks and minerals	1
6	Examination of soil profile in the field	1
7	Determination of bulk density; particle density and porosity of soil	1
8	Determination of organic carbon of soil	1
9	Identification of nutrient deficiency symptoms of crops in the field	1
10	Determination of gypsum requirement of sodic soils	1
11	Identification and description of important fruits, flowers and vegetables crops	1
12	Study of different garden tools, Preparation of nursery bed	1
13	Practices of pruning and training in some important fruit crops	1
14	Study of cultural operations for vegetable crops (sowing, fertilizer application, mulching, irrigation and weed control)	1
15	Seed extraction techniques	1
16	Visit to commercial greenhouse/ polyhouse	1
	Total	16

Suggested Reading

- 1) Ahamad S, Anwar Ali and Sharma P K (Eds.). 2018. *Plant disease management in Horticultural crops*. Daya Publishing House, Delhi.
- 2) Biswas T D and Mukharjee S K. 1987. *A text book of soil science*. Tata McGraw-Hill publishing Co. Ltd.
- 3) Brady N C and Ray R Weill. 2002. *The nature and properties of soil*. Pearson Education Inc. New Delhi.
- 4) Chadha K L. 2003. *Hand Book of Horticulture*. ICAR Publication, New Delhi.
- 5) Das D K. 2020. *Introductory to Soil Science*. Kalyani publication, Ludhiana.
- 6) Dey G C. 2013. *Fundamentals of Agronomy*. Jain Book Depot.
- 7) Ghildyal B P and Tripathy R P. 1987. *Soil Physics*. Wiley Eastern Ltd., New Delhi.
- 8) Hillel D. 1982. *Introduction to Soil Physics*. Academic Press, New York.
- 9) Indian Society of soil science. 2002. *Fundamentals of soil science*. ISSC, IARI, New Delhi.
- 10) Janick J. 1979. *Horticultural Science*. Surjeet Publications, Delhi.
- 11) Kumar N. 2017. *Introduction to Horticulture*. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
- 12) Muthukrishnan N, Ganapathy N, Nalini R and Rajendran R. 2005. *Pest Management in Horticultural crops*. New Madura Publishers, Madurai, Tamil Nadu.
- 13) Reddy S R. 2020. *Principles of Agronomy*. Kalyani Publisher.
- 14) Reddy Yellamanda T and Reddy Shankar G H. 1995. *Principles of Agronomy*. Kalyani Publishers Ludhiana.
- 15) Sehgal J L. 1996. *Soil Pedology*. Kalyani publication, Ludhiana.
- 16) Singh Jitendra. 2018. *Fundamentals of Horticulture*. Kalyani Publishers, Ludhiana.
- 17) Singh S S and Singh R. 2013. *Principles and practices of Agronomy*. Kalyani Publisher.
- 18) Sudheer K P and Indira V. 2016. *Post harvest technology of Horticultural crops*., New Delhi.

SEMESTER – 1

Sr. No.	Course Name	Course No.	Credit	L	P	T
3	Introduction to Agricultural Engineering	CAE1.3	4(3+1)	3	1	4

Objective

To enable the students to have basic idea on different agricultural engineering applications and the machinery involved in different farm operations, post-harvest and allied activities

Theory

Agricultural Engineering as a discipline; Major divisions of Agricultural Engineering; Importance of Agricultural Engineering for today's agriculture; Different sectors of employment for Agricultural Engineers; Scope of research and higher studies in Agricultural Engineering in India and abroad

Farm mechanization needs and strategy; Classification of farm machinery on the basis of unit operations; Principles of selection of machinery for different sizes of land and matching power sources; Different types of equipment for tillage, sowing, planting and transplanting, fertilizer application, weed control, plant protection; Harvesting and threshing equipment for rice, wheat, maize, cotton, sugarcane, fruits, tuber crops and other locally important crops; Functions and capabilities of tractor and power tillers; Introduction to the IC engine systems,

fuel and air supply systems, cooling and lubricating systems, and electrical systems in a tractor; Basic parts of a power tiller; Hitching system

Introduction to renewable energy systems; Types of biogas plants, Types of solar energy collectors; Solar water heating systems, solar dryers, solar photovoltaic systems; Wind mills and their different parts

Importance of soil and water conservation; Different agronomic measures for control of water erosion, mixed cropping, crop rotation, tillage practices, mulching; Different engineering measures; gully control measures

Use of topographical survey and contour maps. Different types of water harvesting structures

Introduction to soil-plant-water relationship; Equipment for measurement of irrigation water, viz. weirs, notches, orifices and mouth pieces; Introduction to different surface irrigation methods as border, furrow and check basin, sprinkler, drip irrigation and their different components; Underground water conveyance methods in pipes; Introduction to planning of drainage systems; Introduction to centrifugal pumps and different components

Different types of agricultural structures; Introduction to planning and layout of farmsteads, animal houses, poultry houses; Different types of grain storage structures; Greenhouse and its different parts; Low cost protected structures

Classification of different types of agricultural commodities as durables, perishables, etc.; moisture content and its importance in grain storage; Common reasons of food spoilage, food preservation methods; Different primary processing operations and their necessity; Methods and equipment used for cleaning, washing, sorting, grading, peeling, size reduction; Different types of traditional and modern storage structures; Storage of perishable commodities; Different types of packaging materials and their suitability for various food products; Basic principles of value addition of food as drying and dehydration, evaporation, thermal processing, refrigerated and frozen storage, chemical preservation and other novel methods

Practical

Study of various implements (tillage, sowing, planting, weeding, fertilizer application); Study of farm implements (pesticide application, harvesting and threshing); Study of various components of tractor and matching implements; Study of various components of power tiller and matching implements ; Study of various types of biogas plants and operational parameters; Study of various solar energy application systems; Study on various components of sprinkler and drip irrigation; Study on various components centrifugal pump; Study of various post-harvest operations; Study of different food processing equipment; Value addition of common crops; Visit to a greenhouse with modern irrigation system; Visit to implement manufacturing unit; Visit to a mechanized farm; Visit to a watershed; Visit to a food processing industry.

Planning of lectures		
S/N	Topics to be covered in lecture	Proposed No. of Lecture
1	Agricultural Engineering as a discipline; Major divisions of Agricultural Engineering; Importance of Agricultural Engineering for today's agriculture; Different sectors of employment for Agricultural Engineers; Scope of research and higher studies in Agricultural Engineering in India and abroad	3
2	Farm mechanization needs and strategy; Classification of farm machinery	3

	on the basis of unit operations; Principles of selection of machinery for different sizes of land and matching power sources;	
3	Different types of equipment for tillage, sowing, planting and transplanting, fertilizer application, weed control, plant protection; Harvesting and threshing equipment for rice, wheat, maize, cotton, sugarcane, fruits, tuber crops and other locally important crops;	4
4	Functions and capabilities of tractor and power tillers	2
5	Introduction to the IC engine systems, fuel and air supply systems, cooling and lubricating systems, and electrical systems in a tractor;	2
6	Basic parts of a power tiller; Hitching system	1
7	Introduction to renewable energy systems; Types of biogas plants,	2
7	Types of solar energy collectors; Solar water heating systems, solar dryers, solar photovoltaic systems	2
8	Wind mills and their different parts	1
9	Importance of soil and water conservation; Different agronomic measures for control of water erosion, mixed cropping, crop rotation, tillage practices, mulching; Different engineering measures; gully control measures	3
10	Use of topographical survey and contour maps Different types of water harvesting structures	2
11	Introduction to soil-plant-water relationship; Equipment for measurement of irrigation water, viz. weirs, notches, orifices and mouth pieces	2
12	Introduction to different surface irrigation methods as border, furrow and check basin, sprinkler, drip irrigation and their different components;	3
13	Underground water conveyance methods in pipes	2
14	Introduction to planning of drainage systems	2
15	Introduction to centrifugal pumps and different components	2
16	Different types of agricultural structures; Introduction to planning and layout of farmsteads, animal houses, poultry houses	2
17	Different types of grain storage structures; Greenhouse and its different parts; Low cost protected structures	2
18	Classification of different types of agricultural commodities as durables, perishables, etc.; moisture content and its importance in grain storage; Common reasons of food spoilage, food preservation methods	2
19	Different primary processing operations and their necessity; Methods and equipment used for cleaning, washing, sorting, grading, peeling, size reduction	2
20	Different types of traditional and modern storage structures; Storage of perishable commodities;	2
21	Different types of packaging materials and their suitability for various food products;	2
22	Basic principles of value addition of food as drying and dehydration, evaporation, thermal processing, refrigerated and frozen storage, chemical preservation and other novel methods	3
	Total	51

Practical

Practical

Sr.No.	Topic	No. of Practical's
1	Study of various implements (tillage, sowing, planting, weeding, fertilizer application)	2
2	Study of farm implements (pesticide application, harvesting and threshing)	1
3	Study of various components of tractor and matching implements	1
4	Study of various components of power tiller and matching implements	1
5	Study of various types of biogas plants and operational parameters	1
6	Study of various solar energy application systems	1
7	Study on various components of sprinkler and drip irrigation	1
8	Study on various components centrifugal pump	1
9	Study of various post-harvest operations	1
10	Study of different food processing equipment; Value addition of common crops	1
11	Visit to a greenhouse with modern irrigation system	1
12	Visit to implement manufacturing unit	1
13	Visit to a mechanized farm	1
14	Visit to a watershed	1
15	Visit to a food processing industry	1
	Total	16

Suggested Reading

1. Chakraverty A. 1999. *Post Harvest Technology of cereals, pulses and oilseeds*. Oxford & IBH publishing Co. Ltd., New Delhi.
2. Dash S K, Bebartta J P and Kar. 2012. A. *Rice Processing and Allied Operations*. Kalyani Publishers, New Delhi.
3. Jain S C and Philip G. 2009. *Farm Machinery - An approach*. Second Edition. Standard Publishers and Distributors, New Delhi.
4. Mal B C. 2014. *Introduction to Soil and Water Conservation Engineering*. 2014. Kalyani Publishers.
5. Michael A M and Ojha T P. 2003. *Principles of Agricultural Engineering*. Jain Brothers, New Delhi.
6. Michael A M. 2012. *Irrigation: Theory and Practice*. Vikas Publishing House New Delhi
7. Nakra C P. 1980. *Farm Machines and Equipment*. Dhanpat Rai Publishing Company Pvt. Ltd, New Delhi.
8. Rai G D. 1995. *Solar Energy Utilization*. Khanna Publishers, New Delhi.
9. Rai G D. 2013. *Non-Conventional Energy Sources*. Khanna Publishers, New Delhi.
10. Sahay K M and Singh K K. 1994. *Unit operations of Agricultural Processing*. Vikas Publishing house Pvt. Ltd. New Delhi.
11. Suresh R and Kumar Sanjay. 2018. *Farm Power and Machinery Engineering*. Standard Publisher Distributors, New Delhi.

SEMESTER – 1

Sr. No.	Course Name	Course No.	Credit	L	P	T
4	Surveying and Levelling	SWCE1.4	3(1+2)	1	2	3

Objective

To enable the students to conduct the survey work for any area and also to prepare layout of engineering structures

Theory

Surveying: introduction, classification and basic principles; Linear measurements, chain surveying, cross staff survey, compass survey, planimeter; Errors in measurements, their elimination and correction; Plane table surveying, methods, advantages and disadvantages

Levelling, leveling difficulties and error in leveling, contouring, computation of area and volume;

Theodolite traversing, introduction to setting of curves; Total station, electronic theodolite; Introduction to GPS survey.

Practical

Linear measurements using different instruments; Reconnaissance survey in the field; Use of field book; Study on various types of chain used in chain survey and its components; Study of errors in chain surveying; Use of ranging rods and ranging in the field; Obstacles during chaining; Offsets in chain survey; Cross Staff; Survey of an area; Preparation of map; Study on various types of compass; Compass survey of an area; Plotting of compass survey; Plane table surveying and different methods; Study on various types of levels and its components; Setting up of dumpy level in the field; Computation of various methods for RL; Study on Levelling, L section and X sections and its plotting; Measurement of slope in the field; Study on contour and its characteristics; Contour survey of an area and preparation of contour map; Introduction of software in drawing contour; Theodolite surveying; Ranging by Theodolite; Height of object by using Theodolite; Setting out curves by Theodolite; Use of minor instruments; Use of total station, EDM in the field; Use of modern computers for surveying

Planning of lectures		
SN	Topics to be covered in lecture	Proposed No. of Lecture
1	Introduction of Subject	1
2	Classification and basic principles of surveying	1
3	Linear measurements	2
4	Chain surveying	1
5	Cross staff survey	1
6	Compass survey	2
7	Errors in measurements , their elimination and correction	2
8	Plane table surveying	1
9	Different methods of Plane table survey	2
10	Fundament about Levelling	1
11	Leveling difficulties and error in leveling	2

12	Contouring	2
13	Computation of area and volume	1
14	Theodolite traversing	2
15	Introduction to setting out of curves	1
16	Introduction about Advance instrument's like Total station, electronic theodolite	1
17	Introduction to GPS survey.	1
	Total	24

Practical		
Sr.No.	Topic	No. of Practical's
1	Linear measurements using different instruments;	1
2	Reconnaissance survey in the field;	1
3	Use of field book and chain survey	1
4	Study on various types of chain used in chain survey and its components;	1
5	Study of errors in chain surveying;	1
6	Field survey with ranging rod and ranging	1
7	Field practical on Obstacles during chaining;	1
8	Field Offsets survey with chain	1
9	Field survey using Cross Staff;	1
10	Survey of an area using chain	1
11	Preparation of map for surveyed data set on field.	1
12	Study on various types of compass;	1
13	Compass survey of an area;	1
14	Plotting of compass survey;	1
15	Plane table surveying and different methods;	1
16	Study on various types of levels and its components;	1
17	Setting up of dumpy level in the field;	1
18	Computation of various methods for RL;	1
19	Study on Levelling,	1
20	L section and X sections and its plotting;	2
21	Measurement of slope in the field;	1
22	Study on contour and its characteristics;	2
23	Contour survey of an area and preparation of contour map;	1
24	Introduction of software in drawing contour;	2
25	introduction to Theodolite surveying;	1
26	Carry out Ranging by Theodolite on field	1
27	Calculation of Height of object by using Theodolite	1
28	Setting out curves by Theodolite on field	1
29	Use of minor instruments;	1
30	Use of total station and field survey	2
31	survey with EDM in the field;	1
32	Use of modern computers for surveying	1
	Total	36

Suggested Reading

1. Agor R. *A Text Book of Surveying & Levelling*. Khanna Publishers, New Delhi
2. Arora K R. 1990. *Surveying (Vol.I)*, Standard Book House, Delhi.
3. Kanetkar T P. 1993. *Surveying and Levelling*. Pune Vidyarthi Griha, Prakashan, Pune.
4. Punmia B C. 1987. *Surveying (Vol.I)*. Laxmi Publications, New Delhi.

SEMESTER – 1

Sr. No.	Course Name	Course No.	Credit	L	P	T
5	Engineering Drawing	FMPE1.5	2(0+2)	0	2	2

Objective

To enable the students to draw engineering drawings for some simple machines/ equipment

Practical

Introduction to engineering drawing, practice of different layout drawings; Drawing instruments and their use; Introduction to lines, letterings, single stroke letters and gothic letters; Dimensioning, dimension line, extension line, arrow head, continuous and progressive dimensioning; Introduction of drawing scales, representative fraction; Practice on orthographic projections, references planes, points and lines in space; Drawing for orthographic projection of points by first angle projection method; Third angle methods of projection; Projection of planes; Projections of solids: polyhedra, cylinder, cone; Projections of solids: prisms and pyramids; Development of surfaces of geometrical solids; Drawing the section of solids: cylinder, cone and sphere; Introduction to isometric scale, isometric view and isometric drawing; Isometric projection of geometrical solids; Preparation of working drawing from models and isometric views; Sectional drawing of simple machine parts; Nomenclature, thread profiles, multi start threads, left and right hand threads; Conventional representation of threads; Forms of screw threads like metric thread, whit worth thread; Square thread: acme thread, knuckle thread, buttress thread; Square headed and hexagonal nuts and bolts; Different types of lock nuts, studs, machine screws, cap screws and wood screws; Processes for producing leak proof joints; Drawing of different types of rivet heads and riveted joints and foundation bolts; Drawing of stud screws, set screws, butt, hexagonal and square; Drawing of keys: taper, rank taper, hollow saddle etc.; Symbols for different types of welded joints.

Planning of Practical		
Sr. No	Topics to be covered in Practical	No. of Practical
1	Introduction to engineering drawing, practice of different layout drawings; Drawing instruments and their use	2
2	Introduction to lines, letterings, single stroke letters and gothic letters; Dimensioning, dimension line, extension line, arrow head, continuous and progressive dimensioning	2
3	Introduction of drawing scales, representative fraction	1
4	Practice on orthographic projections, references planes, points and lines in space	2
5	Drawing for orthographic projection of points by first angle projection method;	2
6	Third angle methods of projection; Projection of planes	2
7	Projections of solids: polyhedra, cylinder, cone; Projections of solids: prisms and pyramids;	3

8	Development of surfaces of geometrical solids	2
9	Drawing the section of solids: cylinder, cone and sphere;	2
10	Introduction to isometric scale, isometric view and isometric drawing; Isometric projection of geometrical solids;	3
11	Preparation of working drawing from models and isometric views;	2
12	Sectional drawing of simple machine parts	2
13	Nomenclature, thread profiles, multi start threads, left and right hand threads; Conventional representation of threads; Forms of screw threads like metric thread, whit worth thread; Square thread: acme thread, knuckle thread, buttress thread	2
14	Square headed and hexagonal nuts and bolts; Different types of lock nuts, studs, machine screws, cap screws and wood screws; Processes for producing leak proof joints;	2
15	Drawing of different types of rivet heads and riveted joints and foundation bolts; Drawing of stud screws, set screws butt, hexagonal and square; Drawing of keys:taper, rank taper, hollow saddle etc.	2
16	Symbols for different types of welded joints.	1
	Total	32

Suggested Reading

1. Bhat N D. 2010. Elementary Engineering Drawing. Charotar Publishing House Pvt. Ltd., Anand.
2. Bhatt N D and Panchal V M. 2013. Machine Drawing. Charotar Publishing House Pvt. Ltd., Anand.
3. Narayana K L and Kannaiah P. 2010. Machine Drawing. Scitech Publications (India) Pvt. Ltd., Chennai.

SEMESTER – 1

Sr. No.	Course Name	Course No.	Credit	L	P	T
6	Basic Electrical Gadgets and Instruments	REE1.6	2+1	2	1	3

Objective

To enable the students to take up repair and maintenance of different common electrical gadgets and instruments.

Theory

Introduction to different electrical appliances used in agricultural buildings, structures and farm operations; Difference between AC and DC supply system; Introduction to AC fundamentals; AC through series RL, RC, and RLC circuits, parallel AC circuit, series and parallel resonance; Q-factor & bandwidth

Three- phase AC circuit: Concept of balanced three-phase AC circuits, line and phase quantity in star and delta network, power in three-phase circuit, various methods of three phase power measurement like (one wattmeter and two –wattmeter method).

Diode and its applications: Rectifier, Clipper, Clamper, voltage multiplier& capacitive filter zener diode as voltage regulator

Transistor and its applications: Bipolar junction transistor, operating point. various biasing methods, fixed, self biasing and potential divider biasing method; OP-AMP, Ideal OP-AMP

characteristics, Linear and non-linear applications of OP-AMP (adder, subtractor, integrator, active rectifier, comparator)

Introduction to digital electronics and logic gates: Basic theorem of boolean algebra, combinational logic circuits (basic gates. SOP rule and K-map), binary adder

Principles of general instruments, measurement of displacement, temperature, velocity, force and pressure using different instruments like strain gauges, load cell, thermistors, thermocouples, pyrometer, linear variable differential transformer (LVDT), capacitive transducers, RTD, instruments for measurement of speed, wind velocity, solar radiation, anemometer, multimeter, etc.

Practical

Basic Electrical & Electronics Gadgets

To prepare an electrical switch board to control two light points, one plug point, one fan point and fuse (House wiring); To prepare an electrical switch board to control two light points using two two-way switch (staircase wiring); To connect and test a fluorescent lamp; To find faults and repair home appliances such as heater, electric iron, fans and mixer-grinder, etc.; To find faults and repair UPS; To measure the power requirement and power factor in a AC single phase series RLC circuit; To measure energy of a single phase AC circuit with the help of ammeter, voltmeter and power factor meter and energy meter; To measure the power consumption in a three-phase circuit using two-wattmeter method

Instrumentation

To prepare a DC power supply unit using diode and filter circuit; To study the Zener diode as voltage regulator circuit; To study transistor characteristics in CE configurations; To verify different logic gates; To measure unknown resistance using Wheatstone bridge; To measure the displacement and to determine the characteristics of LVDT; To measure the displacement using LVDT and potentiometer; To measure the pressure using strain gauge and Bourdentube; To measure the temperature using RTD, thermistors and thermocouple and study their characteristics; To measure the speed, wind velocity, solar radiation etc, using different measuring tools like tachometer, anemometer, pyranometer, multimeter, etc.; To acquaint with different other types of instruments used in agriculture and food processing applications.

Planning of lectures		
SN	Topics to be covered in lecture	Proposed No. of Lecture
1	Introduction to different electrical appliances used in agricultural buildings, structures and farm operations.	2
2	Difference between AC and DC supply system; Introduction to AC fundamentals.	2
3	AC through series RL, RC, and RLC circuits, parallel AC circuit, series and parallel resonance; Q-factor & bandwidth.	2
4	Three- phase AC circuit: Concept of balanced three-phase AC circuits.	2
5	line and phase quantity in star and delta network, power in three-phase circuit.	2
6	Various methods of three phase power measurement like (one wattmeter and two –wattmeter method).	2
7	Diode and its applications: Rectifier.	2
8	Clipper, Clamper, voltage multiplier & capacitive filter zener diode as voltage regulator.	2
9	Transistor and its applications: Bipolar junction transistor, operating point. various biasing methods, fixed, self biasing and potential divider	2

	biasing method.	
10	OP-AMP, Ideal OP-AMP characteristics, Linear and non-linear	2
11	Applications of OP-AMP (adder, subtractor, integrator, active rectifier, comparator).	2
12	Introduction to digital electronics and logic gates: Basic theorem of boolean algebra.	2
13	Combinational logic circuits (basic gates. SOP rule and K-map), binary adder.	2
14	Principles of general instruments, measurement of displacement, temperature, velocity,	2
15	force and pressure using different instruments like strain gauges, load cell, thermistors, thermocouples,	2
16	pyrometer, linear variable differential transformer (LVDT), capacitive transducers, RTD,	2
17	instruments for measurement of speed, wind velocity, solar radiation, anemometer, multimeter, etc.	2
	Total	34

Practical		
Sr.No.	Topic	No. of Practical's
1	To prepare an electrical switch board to control two light points, one plug point, one fan point and fuse (House wiring);	1
2	To prepare an electrical switch board to control two light points using two two-way switch (staircase wiring);	1
3	To connect and test a fluorescent lamp; To find faults and repair home appliances such as heater, electric iron, fans and mixer-grinder, etc.;	1
4	To find faults and repair UPS; To measure the power requirement and power factor in a AC single phase series RLC circuit;	1
5	To measure energy of a single phase AC circuit with the help of ammeter, voltmeter and power factor meter and energy meter;	1
6	To measure the power consumption in a three-phase circuit using two-wattmeter method	1
7	To prepare a DC power supply unit using diode and filter circuit;	1
8	To study the Zener diode as voltage regulator circuit;	1
9	To study transistor characteristics in CE configurations	1
10	To verify different logic gates;	1
11	To measure unknown resistance using Wheatstone bridge;	1
12	To measure the displacement and to determine the characteristics of LVDT;	1
13	To measure the displacement using LVDT and potentiometer;	1
14	To measure the pressure using strain gauge and Bourdentube;	1
15	To measure the temperature using RTD, thermistors and thermocouple and study their characteristics;	1
16	To measure the speed, wind velocity, solar radiation etc, using different measuring tools like tachometer, anemometer, pyranometer, multimeter,	1

	etc.	
17	To acquaint with different other types of instruments used in agriculture and food processing applications.	1
	Total	17

Suggested Reading

1. Boylestad R L and Nashelsky L N. 2011. *Electronic Device and Circuit Theory*. Pearson.
2. Ghosh S. 2007. *Fundamentals of Electrical & Electronics Engineering*, Second edition. PHI Learning, New Delhi
3. Metha V K and Metha R. 2012. *Basic Electrical Engineering*, Fifth edition. S Chand & Co., New Delhi
4. Metha V K and Metha R. 2012. *Principle of Electronics*, Fifth edition. S Chand & Co., New Delhi
5. Rajput R K. 2007. *Basic Electrical and Electronics Engineering*. Laxmi Publications, New Delhi
6. Theraja B L and Theraja A K. 2005. *A Text Book of Electrical Technology Vol. I & II*. SChand & Co., New Delhi

SEMESTER – 1

Sr. No.	Course Name	Course No.	Credit	L	P	T
7	Agricultural Informatics and Artificial Intelligence	VAC-II	3(2+1)	2	1	3

Objective

- To acquaint students with the basics of computer applications in agriculture, multimedia, database management, application of mobile app and decision- making processes, etc.
- To provide basic knowledge of computer with applications in Agriculture.
- To make the students familiar with Agricultural-Informatics, its components and applications in agriculture.

Theory

Introduction to Computers, Anatomy of Computers, Memory Concepts, Units of Memory, Operating System: Definition and types, Applications of MS-Office for creating, Editing and

Formatting a document, Data presentation, Tabulation and graph creation, Statistical analysis, Mathematical expressions, Database, concepts and types, creating database, Uses of DBMS in Agriculture, Internet and World Wide Web (www): Concepts and components.

Computer programming: General concepts, Introduction to Visual Basic, Java, Fortran, C/ C++, etc. concepts and standard input/output operations.

e-Agriculture, Concepts, design and development, Application of innovative ways to use information and communication technologies (IT) in Agriculture, Computer Models in Agriculture: Statistical, weather analysis and crop simulation models, concepts, structure,

inputs-outputs files, limitation, advantages and application of models for understanding plant processes, sensitivity, verification, calibration and validation, IT applications for computation of water and nutrient requirement of crops, Computer-controlled devices (automated systems) for Agri-input management, Smartphone mobile apps in agriculture for farm advice: Market price, postharvest management etc., Geospatial technology: Concepts, techniques, components and uses for generating valuable agri- information, Decision support systems: Concepts, components and applications in Agriculture, Agriculture Expert System, Soil Information Systems etc. for supporting farm decisions. Preparation of contingent crop-planning and crop calendars using IT tools, Digital India and schemes to promote digitalization of agriculture in India.

Practical

Study of computer components, accessories, practice of important DoS Commands, Introduction of different operating systems such as Windows, Unix/ Linux, creating files & folders, File Management. Use of MS-WORD and MS Power-point for creating, editing and presenting a scientific documents, MS- EXCEL - Creating a spreadsheet, Use of statistical tools, Writing expressions, Creating graphs, Analysis of scientific data, Handling macros. MS-ACCESS: Creating Database, preparing queries and reports, Demonstration of Agri-information system, Introduction to World Wide Web (WWW) and its components, Introduction of programming languages such as Visual Basic, Java, Fortran, C, C++, Hands on practice on Crop Simulation Models (CSM), DSSAT/Crop-Info/Crop Syst/ Wofost, Preparation of inputs file for CSM and study of model outputs, computation of water and nutrient requirements of crop using CSM and IT tools, Use of smart phones and other devices in agro-advisory and dissemination of market information, Introduction of Geospatial Technology, Hands on practice on preparation of Decision Support System, Preparation of contingent crop planning, India Digital Ecosystem of Agriculture (IDEA)

Planning of lectures		
SN	Topics to be covered in lecture	Proposed No. of Lecture
1	<p>Module 1: Introduction to Computers and Basic Applications</p> <ol style="list-style-type: none"> 1. Introduction to Computers: Definition, components, and functions. 2. Anatomy of Computers: Hardware, software, input/output devices. 3. Memory Concepts and Units of Memory. 4. Operating Systems: Definition, types, functions, and applications. 5. MS-Office Applications (MS Word, Excel, PowerPoint): Document creation, editing, formatting, graphing, and data presentation. 6. Database Management Systems (DBMS): Introduction, types, and applications in agriculture. 	6
2	<p>Module 2: Internet, Programming, and e-Agriculture</p> <ol style="list-style-type: none"> 7. Introduction to the Internet and WWW: Concepts, components, and uses in agriculture. 8. Computer Programming Basics: Introduction to Visual Basic, Java, Fortran, C, C++. 9. e-Agriculture: Concepts, design, and development. 10. ICT Applications in Agriculture: Role of IT in farming and rural development. 	6

	<p>11. Computer Models in Agriculture: Statistical models, weather analysis, and crop simulation models.</p> <p>12. Computer-Controlled Devices: Automated systems for Agri-input management.</p>	
3	<p>Module 3: IT in Agriculture and Decision Support Systems</p> <p>13. IT Applications for Crop Water and Nutrient Requirements.</p> <p>14. Smartphone Applications in Agriculture: Market price tracking, farm advice, postharvest management.</p> <p>15. Geospatial Technology in Agriculture: Concepts, techniques, and applications.</p> <p>16. Decision Support Systems (DSS): Concepts, components, and applications.</p> <p>17. Agriculture Expert Systems: Soil Information Systems for farm decision support.</p> <p>18. Preparation of Crop Calendars Using IT Tools.</p>	6
4	<p>Module 4: Artificial Intelligence in Agriculture</p> <p>19. Introduction to Artificial Intelligence: Definition, background, and applications.</p> <p>20. Turing Test and Control Strategies.</p> <p>21. Search Strategies in AI: Breadth-first search, depth-first search.</p> <p>22. Heuristic Search Techniques: Best-first search, A* algorithm.</p> <p>23. Big Data and IoT in Agriculture: Use cases and benefits.</p> <p>24. AI-Based Autonomous Crop and Livestock Management.</p>	6
5	<p>Module 5: Smart Agriculture and Digitalization</p> <p>25. AI in Crop Health Monitoring and Intelligent Pesticide Application.</p> <p>26. AI in Precision Agriculture: Yield mapping and predictive analysis.</p> <p>27. Automatic Weeding and Harvesting Systems Using AI.</p> <p>28. AI in Sorting and Food Processing Applications.</p> <p>29. Concepts of Smart Agriculture and AI in Food & Nutrition Science.</p> <p>30. Digital India and Initiatives for Agricultural Digitalization.</p> <p>31. India Digital Ecosystem of Agriculture (IDEA) and Future Prospects.</p> <p>32. Case Studies and Industry Trends in Agricultural Informatics & AI.</p>	8
	Total	32

Practical		
Sr. No.	Topic	No. of Practical's
1	Study of Computer Components and Accessories: Understanding hardware, software, input/output devices, and memory units.	1
2	Practice of Important DOS Commands: Understanding directory management, file handling, and system commands.	1
3	Introduction to Operating Systems (Windows, Unix/Linux) and File Management: Hands-on experience in creating files and folders, navigating directories, and file operations.	1
4	Creating, Editing, and Formatting Scientific Documents Using MS-Word	1
5	MS Excel: Mathematical Calculations and Spreadsheet Preparation: Data	1

	entry, formatting, formulas, charts, and basic statistical analysis.	
6	MS-Access: Creating Databases, Queries, Reports, and Forms: Managing agricultural data using database management software.	1
7	Microsoft PowerPoint for Scientific Presentations: Creating professional presentations with animations and transitions.	1
8	Introduction to the Internet and Web Applications in Agriculture	1
9	Basic HTML for Web Page Creation: Developing simple web pages for agricultural information dissemination.	1
10	Introduction to Programming Languages: Visual Basic, Java, Fortran, C, C++	1
11	Demonstration of Agri-Information Systems: Understanding and exploring various agricultural information systems and portals.	1
12	Hands-on Practice on Crop Simulation Models (CSM): DSSAT/Crop-Info/CropSyst/Wofost	1
13	Use of Smartphone Apps for Agro-Advisory and Market Information: Exploring mobile applications for real-time farming insights.	1
14	Digital Agriculture and India Digital Ecosystem for Agriculture (IDEA): Understanding government initiatives in digital agriculture and its impact.	1
15	Introduction to Geospatial Technology for Agriculture: Basics of GIS, remote sensing, and their applications in precision farming.	1
16	Demonstration of Decision Support System (DSS) and Crop Simulation Models (DSSAT): Learning crop modeling techniques and decision-support tools.	1
		16

Suggested Readings

1. Fundamentals of Computer by V. Rajaroman.
2. Introduction to Information Technology by Pearson.
3. Introduction to Database Management System by C. J. Date.
4. Concepts and Techniques of Programming in C by Dhabal Prasad Sethi and Manoranjan, Wiley India.
5. Introductory Agri Informatics by Mahapatra, Subrat K et al, Jain Brothers Publication.

SEMESTER – 1

Sr. No.	Course Name	Course No.	Credit	L	P	T
8	National Service Scheme (NSS-I)/ OR National cadet corps (NCC- I)	AEC-V AEC-VI	1(0+1)	0	1	0

Course Content: Practical/ Awareness activities

NSS-I

Objectives:

1. To develop qualities of character, courage, comradeship, discipline, leadership, secular outlook, spirit of adventure and sportsmanship and the ideals of selfless service among the youth to make them useful citizen.

2. To create a human resource of organized trained and motivated youth to provide leadership in all walks of life including the Armed Forces and be always available for the service of the nation.

Practical/ Awareness activities

- Arms Drill- Attention, stand at ease, stand easy. Getting on parade. Dismissing and falling out. Ground/take up arms, examine arms. Shoulder from the order and vice- versa, present from the order and vice-versa. Saluting at the shoulder at the halt and on the march. Short/long trail from the order and vice- versa. Guard mounting, guard of honor, Platoon/Coy Drill.
- Characteristics of rifle (.22/.303/SLR), ammunition, fire power, stripping, assembling, care, cleaning, and sight setting. Loading, cocking, and unloading. The lying position and holding.
- Trigger control and firing a shot. Range Procedure and safety precautions. Aiming and alteration of sight. Theory of groups and snap shooting. Firing at moving targets. Miniature range firing. Characteristics of Carbine and LMG.
- Introduction to map, scales, and conventional signs. Topographical forms and technical terms.
- The grid system. Relief, contours, and gradients. Cardinal points and finding north. Types of bearings and use of service protractor. Prismatic compass and its use. Setting a map, finding north and own position. Map to ground and ground to map. Knots and lashings, Camouflage and concealment, Explosives and IEDs.
- Field defenses obstacles, mines and mine lying. Bridging, waterman ship. Field water supplies, tracks and their construction. Judging distance. Description of ground and indication of landmarks. Recognition and description of target. Observation and concealment. Field signals. Section formations. Fire control orders. Fire and
- Orientation: history, objectives, principles, symbol, badge; regular programmes under NSS
- Organizational structure of NSS, Code of conduct for NSS volunteers, points to be considered by NSS volunteers’ awareness about health.
- NSS programme activities. Concept of regular activities, special camping, day camps, basis of adoption of village/slums, conducting survey, analyzing guiding financial patterns of scheme, youth programmes/ schemes of GOI, coordination with different agencies and maintenance of diary. Understanding youth. Definition, profile,
- categories, issues and challenges of youth; and opportunities for youth who is agent of the social change.
- Community mobilization. Mapping of community stakeholders, designing the message as per problems and their culture; identifying methods of mobilization involving youth- adult partnership. Social harmony and national integration
- Indian history and culture, role of youth in nation building, conflict resolution and peace-building. Volunteerism and *shramdaan*. Indian tradition of volunteerism, its need, importance, motivation, and constraints; shaman as part of volunteerism
- Citizenship, constitution, and human rights. Basic features of constitution of India, fundamental rights and duties, human rights, consumer awareness and rights and rights to information. Family and society. Concept of family, community (PRIs and other community-based organizations) and society movement. Movement with/without arms. Section battle drill. Types of communication, media, latest trends and developments.

SEMESTER – 1

Sr. No.	Course Name	Course No.	Credit	L	P	T
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9	Introduction to Engineering Mathematics	AS1.9	3(3+0)* *NG	3	0	3
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Planning of Lectures		
Sr. No	Topics to be covered in lecture	Proposed No. of Lectures
1.	Function: Concept and examples.	4
2.	Co-ordinate Geometry: Point: distance formula, mid-point, locus of point. Straight line: Forms of equation of St Lines, Slope point form, two-point form, Intercept form, parallel and Perpendicular lines Circle: Equation of circle, centre and radius form, tangent and normal and related problems.	4
3.	Limit: Concept of limit, standard formulae and related examples.	4
4.	Differentiation: Definition, Rules of, sum, Product, Quotient of functions, chain rule, Derivative of implicit functions and parametric functions, Logarithmic differentiation, Successive differentiation up to second order.	7
5.	Integration: Concept, integral of standard functions, working rules of integration, Integration by parts, Integration by substitution method, Definite integral and its properties.	8
6.	Vector: Basic concept of vector and scalar, Addition and subtraction, Product of vectors, Geometric meaning of scalar and vector product, Angle between two vectors, Application of Dot (scalar) and Cross (vector) product, Work done and Moment of force.	5
7.	Trigonometry: Units of angles (Degree and Radian), Allied and compound angles, Multiple submultiples angles, Graph of sine and cosine, Periodic function, Sum and factor formulae, Inverse trigonometric function.	5
8.	Matrix: Idea of determinant and matrix, Addition / subtraction, Product, Inverse up to 3x3 matrix.	5
9.	Permutation & combination: Introduction. Fundamental principles of counting, Definition, Factorial notations, Related examples.	2
10.	complex numbers: Introduction, Basic properties of complex number, Representation of complex number, Conjugate of Complex number.	4
Total		48

Sr. No.	Course Number	Course Title	Credit Hours	Total Credit Hours
First Year				
II Semester				
1	FMPE2.1	Workshop Technology and Practice	2 (0+2)	21 (5+16)
2	As per list-@	Skill Enhancement course (1-24)	4(0+4)	
3	As per list-@	Skill Enhancement course (1-24)	4(0+4)	
4	AEC - IV	Computer Programming and Data Structures	2 (0+2)	
5	MDC - I	Farming Based Livelihood Systems	3 (2+1)	
6	VAC - I	Environmental Studies and Disaster Management	3 (2+1)	
7	AEC - I	Communication Skills	2 (1+1)	
8	AEC-VII AEC-VIII	National Service Scheme (NSS- II)/ OR National cadet corps (NCC- II)	1 (0+1)	
Post-II Semester				
9	Int2.9	Internship (for 10 weeks, only for exit option for award of UG-Certificate)	10 (0+10)	

@ Course number will be as per the course selected from the SEC course list-@

SEMESTER – 2

Sr. No.	Course Name	Course No.	Credit	L	P	T
1	Workshop Technology and Practice	FMPE 2.1	2(0+2)	0	2	2

Objective

To expose the students to basic manufacturing processes involved for production of different machine elements and to facilitate hands-on experience of using these machines.

Practical

Introduction about different shops in the workshop; Safety and precautions to be taken in the workshop; Study of different tools used for fitting and different fitting operations; Study of various measuring instruments used for fitting; Exercise in fitting: sawing, filing and right angle fitting of MS flat; Working with complex fitting jobs: operations of drilling, reaming, and threading and with tap dies; Preparation of a paper weight; Study of various carpentry tools, types of wood and their characteristics and working with carpentry tools; Preparation of simple joints in carpentry: cross half lap joint or T-half joint, Mortise and Tenon joint in carpentry; Preparation of dovetail joint in carpentry; Study of welding, types of welding, oxyacetylene gas welding, types of flames, welding techniques and equipment used for gas welding, working with welding equipment; Working with electric arc welding; Equipment and tools, safety and precautions taken in arc welding; Preparation of Butt joint and lap joint with ARC welding; Preparation of Lap and butt joints using gas welding; Working on a lathe machine and study of different tools used in lathe machine; Exercise on simple turning, step turning in lathe machine; Preparation of job on taper turning, drilling, knurling and threading in lathe machine; Working with different machines in machine shop such as shaper, milling machine, etc. and with different tools used in machine shop; Exercise on bending, shaping etc.; Exercise on Drawing, Punching,

Riveting; Making different types of sheet metal joints using G.I. sheets; Practice job on shaper; changing a round MS rod into square section with a shaper; Exercise on a milling machine such as making a slot, gear tooth forming and indexing

Planning of Practical		
Sr. No	Topics to be covered in Practical	No. of Practical
1	Introduction about different shops in the workshop; Safety and precautions to be taken in the workshop.	1
2	Study of different tools used for fitting and different fitting operations.	2
3	Study of various measuring instruments used for fitting.	1
4	Exercise in fitting: sawing, filing and right angle fitting of MS flat; Working with complex fitting jobs: operations of drilling, reaming, and threading and with tap dies; Preparation of a paper weight.	4
5	Study of various carpentry tools, types of wood and their characteristics and working with carpentry tools.	1
6	Preparation of simple joints in carpentry: cross half lap joint or T-half joint, Mortise and Tenon joint in carpentry.	3
7	Preparation of dovetail joint in carpentry.	1
8	Study of welding, types of welding, oxyacetylene gas welding, types of flames, welding techniques and equipment used for gas welding, working with welding equipment;	1
9	Working with electric arc welding; Equipment and tools, safety and precautions taken in arc welding.	1
10	Preparation of Butt joint and lap joint with ARC welding. Preparation of Lap and butt joints using gas welding.	2
11	Working on a lathe machine and study of different tools used in lathe machine.	1
12	Exercise on simple turning, step turning in lathe machine;	1
13	Preparation of job on taper turning, drilling, knurling and threading in lathe machine.	4
14	Working with different machines in machine shop such as shaper, milling machine, etc. and with different tools used in machine shop.	1
15	Exercise on Drawing, Punching, Riveting; Making different types of sheet metal joints using G.I. sheets.	3
16	Practice job on shaper; changing a round MS rod into square section with a shaper.	3
17	Exercise on a milling machine such as making a slot, gear tooth forming and indexing.	2
Total		32

Suggested Reading

1. Chapman W AJ. 2018. Workshop Technology (Vol. I and II). Arnold Publishers (India) Pvt. Ltd., AB/9, Safdarjung Enclave, New Delhi.
2. Hajra Choudhury S K, Roy N, Hajra Choudhury A K. 2017. Elements of Workshop Technology (Vol. I and II). Media Promoters and Publishers Pvt. Ltd., Mumbai.
3. Khurmi R S and Gupta J K. 2018. A Text Book of Workshop Technology. S. Chand & Company Ltd., New Delhi.

4. Raghuwansi B S. 2016. A Course in Workshop Technology (Vol. I and II). Dhanpat Rai and Sons, 1682, Nai Sarak, New Delhi.

SEMESTER – 2

Sr. No.	Course Name	Course No.	Credit	L	P	T
4	Computer Programming and Data Structures	AEC-IV	2(0+2)	0	2	2

Objective

To make the students conversant on computer programming languages, specifically “C” language as well as to make him familiar with programming for simple agricultural engineering applications

Practical

Introduction to high level languages; structure programming, C programming, a simple C programming, execution of a ‘C’ program, program and instruction; Familiarizing with Turbo C IDE; Building an executable version of C program; Study of different operators such as arithmetic, relational, logical, assignment, increment and decrement, conditional, bitwise and special operators, precedence of arithmetic operators; Debugging a C program; Developing and executing simple programs; Creating programs using decision making statements such as if, go to & switch; Developing program using loop statements while, do & for; Using nested control structures; Familiarizing with one and two dimensional arrays; Using string functions; Creating user defined functions; Developing structures and union; Using local, global & external variables; Using pointers; Developing linked lists in C language; Inserting an item in Linked List; Deleting an item in Linked List; Implementing Stacks; Implementing push/pop functions; Creating queues, Insertion/Deletion in queues.

Sr. No.	Practical Topic	No. of Practical
1	Introduction to C Programming	1
	1.1 Write, compile, and execute a program that takes user input and prints it back.	
2	Working with Operators	4
	2.1 Write a program to input two numbers and perform addition, subtraction, multiplication, and division. Compare the results using relational operators.	
	2.2 Write a program that accepts three numbers and checks if they are in ascending order using logical operators.	
	2.3 Write a program to demonstrate the use of bitwise operators (AND, OR, XOR, NOT).	
	2.4 Develop a program to evaluate a complex expression and verify operator precedence.	
3	Control Structures	4
	3.1 Write a program using if-else statements to check if a number is positive, negative, or zero.	
	3.2 Write a program using switch-case to perform arithmetic operations based on user input.	
	3.3 Write a program using for loop to print the first 10 natural numbers.	

	3.4	Write a program using while loop to find the factorial of a number.	
	3.5	Write a program using do-while loop to print numbers from 1 to 10.	
	3.6	Write a program to print a pyramid pattern using nested loops.	
4	Arrays and Strings		4
	4.1	Write a program to find the largest element in an array.	
	4.2	Write a program to sort an array in ascending order using bubble sort.	
	4.3	Write a program to concatenate two strings without using library functions.	
	4.4	Write a program to reverse a string.	
5.	Functions		3
	5.1	Write a program to calculate the factorial of a number using a recursive function.	
	5.2	Write a program to swap two numbers using call by value and call by reference.	
	5.3	Write a program to check if a number is prime using a function.	
6.	Pointers		3
	6.1	Write a program to demonstrate the use of pointers to access array elements.	
	6.2	Write a program to swap two numbers using pointers.	
	6.3	Write a program to find the length of a string using pointers.	
	6.4	Write a program to reverse an array using pointers.	
7	Structures and Unions		2
	7.1	Write a program to store and display student information (name, roll no, marks) using structures.	
	7.2	Write a program to demonstrate the use of unions.	
8	File Handling		3
	8.1	Write a program to create a file and write data into it.	
	8.2	Write a program to read data from a file and display it on the screen.	
	8.3	Write a program to append data to an existing file.	
9	Linked Lists		3
	9.1	Write a program to create a singly linked list and display its elements.	
	9.2	Write a program to insert and delete an element from a linked list.	
	9.3	Write a program to reverse a linked list.	
10	Stacks and Queues		3
	10.1	Write a program to implement stack operations (push, pop, display).	
	10.2	Write a program to implement queue operations (insert, delete, display).	
	10.3	Write a program to implement a circular queue.	
	10.4	Write a program to implement a double-ended queue (deque).	
11	Trees		2
	11.1	Write a program to create a binary tree and perform inorder traversal.	
	11.2	Write a program to perform preorder and postorder traversal of a binary tree.	

Suggested Reading

1. Rajaraman V. 1985. *Computer Oriented Numerical Methods*. Prentice Hall of India. Pvt. Ltd., New Delhi.
2. Balagurusamy E. 1990. *Programming in 'C'*. Tata McGraw Hill Publishing Co. Ltd.,

- 12/4 Asaf Ali Road, New Delhi.
3. Rajaraman V. 1995. *Computer Programming in 'C'*. Prentice Hall of India Pvt. Ltd., New Delhi.
 4. Bronson G and Menconi S. 1995. *A First Book of 'C' Fundamentals of 'C' Programming*. Jaico Publishing House, New Delhi.
 5. Sahni S. 2006. *Data Structures, Algorithms and Applications in C++*. University Press (India) Pvt. Ltd / Orient Longman Pvt. Ltd.
 6. Goodrich M T, Tamassia R and Mount D. 2011. *Data structures and Algorithms in C++*. Wiley Student Edition, John Wiley and Sons.
 7. Weiss M A. 2007. *Data Structures and Algorithm Analysis in C++*. Pearson Education.
 8. Augenstein L and Tanenbaum. 2003. *Data structures using C and C++*. PHI/Pearson Education.
 9. Drozdek A. 2012. *Data Structures and Algorithms in C++*. Vikas Publishing House / Thomson International Student Edition.
 10. Agarwal A. 2005. *The Complete Reference Guide: Data Structure through C*. ISBN: 8178840448; Publisher: Cyber Tech Publications.

SEMESTER – 2

Sr. No.	Course Name	Course No.	Credit	L	P	T
5	Farming based livelihood systems	MDC - I	3(2+1)	2	1	3

Course Content:

Theory

Status of agriculture in India and different states, Income of farmers and rural people in India, Livelihood-Definition, concept and livelihood pattern in urban & rural areas, Different indicators to study livelihood systems. Agricultural livelihood systems (ALS) : Meaning, approach, approaches and framework , Definition of farming systems and farming based livelihood systems Prevalent Farming systems in India contributing to livelihood. Types of traditional & modern farming systems. Components of farming system/ farming based livelihood systems- Crops and cropping systems, Livestock, (Dairy, Piggery, Goatry, Poultry, Duckry etc.), Horticultural crops, Agro--forestry systems, Aqua culture Duck/Poultry cum Fish, Dairy cum Fish, Piggery cum Fish etc., Small, medium and large enterprises including value chains and secondary enterprises as livelihood components for farmers, Factors affecting integration of various enterprises of farming for livelihood. Feasibility of different farming systems for different agro-climatic zones, Commercial farming based livelihood models by NABARD, ICAR and other organizations across the country, Case studies on different livelihood enterprises associated with the farming. Risk & success factors in farming based livelihood systems, Schemes & programmes by Central & State Government, Public & Private organizations involved in promotion of farming based livelihood opportunities. Role of farming based livelihood enterprises in 21st Century in view of circular economy, green economy, climate change, digitalization & changing life style.

Practical

Survey of farming systems and agricultural based livelihood enterprises, Study of components of important farming based livelihood models/ systems in different agro-climatic zones, Study of production and profitability of crop based, livestock based, processing based and integrated farming based livelihood models, Field visit of innovative farming system models. Visit of Agri-based enterprises & their functional aspects for integration of production, processing &

distribution sectors and Study of agri-enterprises involved in industry and service sectors(Value Chain Models), Learning about concept of project formulation on farming based livelihood systems along with cost & profit analysis, Case study of Start-Ups in agri-sectors.

Planning of Lectures		
Sr. No	Topics to be covered in lecture	Proposed No. of Lectures
1.	Status of agriculture in India and different states, Income of farmers and rural people in India, Livelihood-Definition, concept and livelihood pattern in urban & rural areas. Different indicators to study livelihood systems.	3
2.	Agricultural livelihood systems (ALS) : Meaning, approach, approaches and framework , Definition of farming systems and farming based livelihood systems Prevalent Farming systems in India contributing to livelihood.	3
3.	Types of traditional & modern farming systems. Components of farming system/ farming based livelihood systems- Crops and cropping systems, Livestock, (Dairy, Piggery, Goatry, Poultry, Duckry etc.),	4
4.	Horticultural crops, Agro--forestry systems, Aqua culture Duck/Poultry cum Fish, Dairy cum Fish, Piggery cum Fish etc., Small, medium and large enterprises including value chains and secondary enterprises as livelihood components for farmers,	4
5.	Factors affecting integration of various enterprises of farming for livelihood.	2
6.	Feasibility of different farming systems for different agro-climatic zones, Commercial farming based livelihood models by NABARD, ICAR and other organizations across the country.	4
7.	Case studies on different livelihood enterprises associated with the farming.	4
8.	Risk & success factors in farming based livelihood systems, Schemes & programmes by Central & State Government, Public & Private organizations involved in promotion of farming based livelihood opportunities.	4
9.	Role of farming based livelihood enterprises in 21 st Century in view of circular economy, green economy, climate change, digitalization & changing life style.	4
Total		32

Planning of Practical		
Sr. No	Topics to be covered in Practical	No. of Practical
1.	Survey of farming systems and agricultural based livelihood enterprises.	2
2.	Study of components of important farming based livelihood models/ systems in different agro-climatic zones	2
3.	Study of production and profitability of crop based, livestock based, processing based and integrated farming based livelihood models.	2
4.	Field visit of innovative farming system models	2
5.	Visit of Agri-based enterprises & their functional aspects for integration of production, processing & distribution sectors	2

6.	Study of agri-enterprises involved in industry and service sectors(Value Chain Models)	2
7.	Learning about concept of project formulation on farming based livelihood systems along with cost & profit analysis	2
8.	Case study of Start-Ups in agri-sectors.	2
Total		16

Suggested Readings

- Dixon, J. and A. Gulliver with D. Gibbon. (2001). Farming Systems and Poverty: Improving Farmers' Livelihoods in a Changing World. FAO & World Bank, Rome, Italy & Washington, DC, USA
- Ashley, C.; Carney, D. (1999). Sustainable Livelihoods: Lessons from Early Experience; Department for International Development: London, UK,; Volume 7. [Google Scholar]
- Reddy, S.R. 2016. Farming System and Sustainable Agriculture, Kalyani Publishers, New Delhi.
- Panwar et al. 2020. Integrated Farming System models for Agricultural Diversification, Enhanced Income and employment, Indian Council of Agricultural Research, New Delhi.
- Singh, J.P., et al. 2015. Region Specific Integrated Farming System Models, ICAR-Indian Institute of Farming Systems Research, Modipuram.
- Walia, S. S. and U. S. Walia, 2020. Farming System and Sustainable Agriculture, Scientific Publishers, Jodhpur, Rajasthan.
- Livelihood Improvement of Underprivileged Farming Community : Some Experiences from Vaishali, Samastipur, Darbhanga and Munger Districts of Bihar by B. P. Bhatt, Abhay Kumar, P.K. Thakur, Amitava Dey Ujjwal Kumar, Sanjeev Kumar, B.K. Jha, Lokendra Kumar, K. N. Pathak, A. Hassan , S. K. Singh, K. K. Singh and K. M. Singh ICAR Research Complex for Eastern Region ICAR Parisar, P.O. Bihar Veterinary College, Patna - 800 014, Bihar
- Carlioni, A (2001) Global Farming Systems Study: Challenges and Priorities to 2030 – Regional Analysis: Sub-Saharan Africa, Consultation Document, FAO, Rome, Italy
- Evenson, R.E. (2000). Agricultural Productivity and Production in Developing Countries'. In FAO, The State of Food and Agriculture, FAO, Rome, Italy
- Agarwal, A. & Narain, S. (1989). Towards Green Villages: A strategy for Environmentally, Sound and Participatory Rural Development, Center for Science and Environment, New Delhi, India

SEMESTER – 2

Sr. No.	Course Name	Course No.	Credit	L	P	T
6	Environmental Studies and Disaster Management	VAC - I	3(2+1)	2	1	3

Course Content:

Introduction to Environment - Environmental studies - Definition, scope and importance - Multidisciplinary nature of environmental studies - Segments of Environment - Spheres of Earth - Lithosphere - Hydrosphere - Atmosphere - Different layers of atmosphere. Natural Resources: Classification - Forest resources. Water resources. Mineral resources Food resources. Energy resources. Land resources. Soil resources. Ecosystems - Concept of an ecosystem - Structure and function of an ecosystem - Energy flow in the ecosystem. Types of

ecosystem. Biodiversity and its conservation: Introduction, definition, types. Biogeographical classification of India. Importance and Value of biodiversity. Biodiversity hot spots. Threats and Conservation of biodiversity Environmental Pollution: Definition, cause, effects and control measures of: a. Air pollution. b. Water pollution. c. Soil pollution. d. Marine pollution. e. Noise pollution. f. Thermal pollution h. light pollution. Solid Waste Management: Classification of solid wastes and management methods, Composting, Incineration, Pyrolysis, Biogas production, Causes, effects and control measures of urban and industrial wastes. Social Issues and the Environment: Urban problems related to energy. Water conservation, rain water harvesting, watershed management. Environmental ethics: Issues and possible solutions, climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Environment Protection Act. Air (Prevention and Control of Pollution) Act. Water (Prevention and control of Pollution) Act. Wildlife Protection Act. Forest Conservation Act. Human Population and the Environment: Environment and human health: Human Rights, Value Education. Women and Child Welfare. Role of Information Technology in Environment and human health.

Disaster management - Disaster definition - Types - Natural Disasters - Floods, drought, cyclone, earthquakes, landslides, avalanches, volcanic eruptions, Heat and cold waves. Man Made Disasters - Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire, oil fire, road accidents, rail accidents, air accidents, sea accidents. International and National strategy for disaster reduction. Concept of disaster management, national disaster management framework; financial arrangements; role of NGOs, community- based organizations and media in disaster management. Central, state, district and local administration in disaster control; Armed forces in disaster response; Police and other organizations in disaster management.

Practical

Visit to a local area to document environmental assets river/forest/grassland/hill/mountain. Energy: Biogas production from organic wastes. Visit to wind mill / hydro power / solar power generation units. Biodiversity assessment in farming system. Floral and faunal diversity assessment in polluted and un polluted system. Visit to local polluted site - Urban/Rural/Industrial/Agricultural to study of common plants, insects and birds. Environmental sampling and preservation. Water quality analysis: pH, EC and TDS. Estimation of Acidity, Alkalinity. Estimation of water hardness. Estimation of DO and BOD in water samples. Estimation of COD in water samples. Enumeration of E. coli in water sample. Assessment of Suspended Particulate Matter (SPM). Study of simple ecosystem – Visit to pond/river/hills. Visit to areas affected by natural disaster.

Planning of Lectures		
Sr. No	Topics to be covered in lecture	Proposed No. of Lectures
1.	Introduction to Environment - Environmental studies - Definition, scope and importance - Multidisciplinary nature of environmental studies	2
2.	Segments of Environment - Spheres of Earth - Lithosphere - Hydrosphere - Atmosphere - Different layers of atmosphere.	2
3.	Natural Resources: Classification - Forest resources. Water resources. Mineral resources Food resources. Energy resources. Land resources. Soil resources.	2
4.	Ecosystems - Concept of an ecosystem - Structure and function of an ecosystem - Energy flow in the ecosystem. Types of ecosystem.	2

5.	Biodiversity and its conservation: Introduction, definition, types. Biogeographical classification of India. Importance and Value of biodiversity. Biodiversity hot spots. Threats and Conservation of biodiversity	2
6.	Environmental Pollution: Definition, cause, effects and control measures of: a. Air pollution. b. Water pollution. c. Soil pollution. d. Marine pollution. e. Noise pollution. f. Thermal pollution h. light pollution.	2
7.	Solid Waste Management: Classification of solid wastes and management methods, Composting, Incineration, Pyrolysis, Biogas production, Causes, effects and control measures of urban and industrial wastes.	3
8.	Social Issues and the Environment: Urban problems related to energy. Water conservation, rain water harvesting, watershed management.	2
9.	Environmental ethics: Issues and possible solutions, climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust.	2
10.	Environment Protection Act. Air (Prevention and Control of Pollution) Act. Water (Prevention and control of Pollution) Act. Wildlife Protection Act. Forest Conservation Act.	2
11.	Human Population and the Environment: Environment and human health: Human Rights, Value Education. Women and Child Welfare. Role of Information Technology in Environment and human health.	2
12.	Disaster management - Disaster definition - Types - Natural Disasters - Floods, drought, cyclone, earthquakes, landslides, avalanches, volcanic eruptions, Heat and cold waves.	2
13.	Man Made Disasters - Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire, oil fire, road accidents, rail accidents, air accidents, sea accidents.	2
14.	International and National strategy for disaster reduction. Concept of disaster management, national disaster management framework; financial arrangements; role of NGOs, community- based organizations and media in disaster management.	2
15.	Central, state, district and local administration in disaster control; Armed forces in disaster response; Police and other organizations in disaster management.	3
Total		32

Planning of Practicals		
Sr. No	Topics to be covered in Practical	No. of Practical
1.	Visit to a local area to document environmental assets river/forest/grassland/hill/mountain	1
2.	Energy: Biogas production from organic wastes.	1
3.	Visit to wind mill / hydro power / solar power generation units.	1
4.	Biodiversity assessment in farming system. Floral and faunal diversity assessment in polluted and un polluted system	1

5.	Visit to local polluted site - Urban/Rural/Industrial/Agricultural to study of common plants, insects and birds Environmental sampling and preservation.	2
6.	Water quality analysis: pH, EC and TDS.	1
7.	Estimation of Acidity, Alkalinity.	1
8.	Estimation of water hardness. Estimation of DO and BOD in water samples.	2
9.	Estimation of COD in water samples.	1
10.	Enumeration of E. coli in water sample.	1
11.	Assessment of Suspended Particulate Matter (SPM).	1
12.	Study of simple ecosystem	1
13.	Visit to pond/river/hills.	1
14.	Visit to areas affected by natural disaster	1
Total		16

Suggested Readings

1. De. A.K., 2010. Environmental chemistry. Published by New Age International Publishers, New Delhi. ISBN:13-978 81 224 2617 5. 384 pp
2. DharChakrabarti. P.G., 2011. Disaster management - India's risk management policy frameworks and key challenges. Published by Centre for Social Markets (India), Bangalore. 36 pp.
3. ErachBharucha, Text book for Environmental studies. University Grants Commission, New Delhi
4. Parthiban, K.T. Vennila, S. Prasanthrajan, M. UmeshKanna, S. Forest, Environment, Biodiversity and Sustainable development. Narendra Publishing House, New Delhi, India 2023. (In Press).
5. Prasanthrajan M, P.P. Mahendran., 2008. A text book on Ecology and Environmental Science. ISBN 81-8321-104-6. Agrotech Publishing Academy, Udaipur - 313 002. First Edition: 2008
6. Prasanthrajan M, 2018. Objective environmental studies and disaster management. ISBN 9789387893825. Scientific publishers, Jodhpur, India. Pp. 146.
7. Sharma, P.D. 2009, Ecology and Environment, Rastogi Publications, Meerat, India
8. Tyler Miller and Scot Spoolman. 2009. Living in the Environment (Concepts, Connections, and Solutions). Brooks/cole, Cengage learning publication, Belmont, USA.

SEMESTER – 2

Sr. No.	Course Name	Course No.	Credit	L	P	T
7	Communication Skills	AEC- I	2(1+1)	1	1	2

Objective

To acquire competence in oral, written and non-verbal communication, develop strong personal and professional communication skill and demonstrate positive group communication

Theory

Communication Process: The magic of effective communication; Building self-esteem and overcoming fears; Concept, nature and significance of communication process; Meaning, types and models of communication; Verbal and non-verbal communication; Linguistic and non-

linguistic barriers to communication and reasons behind communication gap/ miscommunication.

Basic Communication Skills: Listening, Speaking, Reading and Writing Skills; Precis writing/ Abstracting/Summarizing; Style of technical communication Curriculum vitae/resume writing; Innovative methods to enhance vocabulary, analogy questions.

Structural and Functional Grammar: Sentence structure, modifiers, connecting words and verbals; phrases and clauses; Case: subjective case, possessive case; objective case; Correct usage of nouns, pronouns and antecedents, adjectives, adverbs and articles; Agreement of verb with the subject: tense, mood, voice; Writing effective sentences; Basic sentence faults.

Practical

Listening and note taking; Writing skills: precis writing, summarizing and abstracting; Reading and comprehension (written and oral) of general and technical articles; Micro-presentations and Impromptu Presentations: Feedback on presentations; Stage manners: grooming, body language, voice modulation, speed; Group discussions; Public speaking exercises; vocabulary building exercises; Interview Techniques; organization of events.

Suggested readings

1. Allport, G. W. 1937. Personality: A Psychological Interpretation. Holt, New York.
2. Brown Michele and Gyles Brandreth. 1994. How to Interview and be Interviewed. Sheldon Press, London.
3. Dale, Carnegie. 1997. The Quick and Easy Way to Effective Speaking. Pocket Books, New York.
4. Francis Peter, S. J. 2012. Soft Skills and Professional Communication. Tata McGraw Hill, New Delhi.
5. Kumar, S and Pushpa Lata. 2011. Communication Skills. Oxford University Press.
6. Neuliep James, W. 2003. Intercultural Communication A Contextual Approach. Houghton Mifflin Co Boston.
7. Pease, Allan. 1998, Body Language. Sudha Publications, Delhi.
8. Raman, M. and Singh, P. 2000. Business Communication. Oxford University Press.
9. Seely, J. 2013. Oxford Guide to Effective Writing and Speaking. Oxford University Press.
10. Thomson, A. J. and Martinet, A. V. 1977. A Practical English Grammar. Oxford University

Planning of Lectures		
Sr. No	Topics to be covered in Lectures	No. of Lectures
1	The Magic of Effective Communication; Building self-esteem and Overcoming fears	1
2	Concept, nature and significance of communication process; Meaning, types and models of communication	1
3	Verbal and non-verbal communication	1
4	Linguistic and non-linguistic barriers to communication and reasons behind communication gap/ miscommunication	1
5	Listening, Speaking, Reading and Writing Skills	1
6	Precis writing/ Abstracting/Summarizing	1
7	Style of technical communication	1
8	Curriculum vitae/resume writing	1
9	Innovative methods to enhance vocabulary and analogy questions.	1
10	Sentence structure, modifiers, connecting words and verbals	1

11	phrases and clauses	1
12	Case: subjective case, possessive case; objective case	1
13	Correct usage of nouns, pronouns and antecedents, adjectives, adverbs and articles	1
14	Agreement of verb with the subject: tense, mood, voice	2
15	Writing effective sentences, Basic sentence faults.	1
Total		16

Planning of Practical		
Sr. No	Topics to be covered in Practical	No. of Practical
1	Listening and note-taking	2
2	Writing skills: precis writing, summarizing and abstracting	1
3	Reading and comprehension (written and oral) of general and technical articles	1
4	Micro-presentations and Impromptu Presentations: Feedback on presentations	3
5	Stage manners: grooming, body language, voice modulation, speed	2
6	Group discussions	1
7	Public speaking exercises	2
8	Vocabulary-building exercises	1
9	Interview Techniques	2
10	Organization of events.	1
Total		16

SEMESTER – 2

Sr. No.	Course Name	Course No.	Credit	L	P	T
8	National Service Scheme (NSS- II)/ OR National cadet corps (NCC- II)	AEC-VII OR AEC-VIII	1(0+1)	0	1	0

NSS- II

Objective

To evoke social consciousness among students through various activities viz., working together, constructive, and creative social work, to be skillful in executing democratic leadership, developing skill in programme, to be able to seek self-employment, reducing gap between educated and uneducated, increasing awareness and desire to help sections of society.

Practical/ Awareness activities

- Importance and role of youth leadership
- Meaning, types and traits of leadership, qualities of good leaders; importance and roles of youth leadership, Life competencies
- Definition and importance of life competencies, problem-solving and decision-making, interpersonal communication. Youth development programmes
- Development of youth programmes and policy at the national level, state level and voluntary

- sector; youth-focused and youth-led organizations
- Health, hygiene and sanitation. Definition needs and scope of health education; role of food, nutrition, safe drinking water, water borne diseases and sanitation (Swachh Bharat Abhiyan) for health; national health programmes and reproductive health. Youth health, lifestyle, HIV AIDS and first aid. Healthy lifestyles, HIV AIDS, drugs and substance abuse, home nursing and first aid. Youth and yoga. History, philosophy, concept, myths, and misconceptions about yoga; yoga traditions and its impacts, yoga as a tool for healthy lifestyle, preventive and curative method

Select any 2 courses from the following Skill Enhancement Courses:

SKILL ENHANCEMENT COURSE MODULES				
1	SEC1	Operation and maintenance of farm Machinery	4 (0+4)	FMPE
2	SEC2	Repair and maintenance of tractors and power tillers	4 (0+4)	FMPE
3	SEC3	Management of agricultural machinery custom hiring and maintenance facilities	4 (0+4)	FMPE
4	SEC4	Fabrication, operation and maintenance of renewable energy devices	4 (0+4)	FMPE
5	SEC5	Operation and maintenance of drones used for agricultural applications	4 (0+4)	FMPE
6	SEC6	Machine vision, sensors and sensors architecture	4 (0+4)	FMPE
7	SEC7	Design of solar PV system using softwares	4 (0+4)	REE
8	SEC8	Installation and maintenance of on-grid and off-grid solar systems	4 (0+4)	REE
9	SEC9	Design and maintenance of agri-voltaic systems	4 (0+4)	REE
10	SEC10	Valorization of agri-biomass and organic waste	4 (0+4)	REE
11	SEC11	Energy audit, energy conservation and energy efficiency	4 (0+4)	REE
12	SEC12	Repair and maintenance of pumps and irrigation systems	4 (0+4)	IDE
13	SEC13	Installation and maintenance of micro- irrigation systems	4 (0+4)	IDE
14	SEC14	Application of remote sensing and GIS for agricultural water management	4 (0+4)	SWCE
15	SEC15	Operation and maintenance of hydro- meteorological instruments	4 (0+4)	SWCE

16	SEC16	Geophysical survey and investigations for groundwater exploration and installation of tube well/ bore well	4 (0+4)	IDE
17	SEC17	Installation and maintenance of roof top rain water harvesting systems	4 (0+4)	SWCE
18	SEC18	Operation and maintenance of soil conservation structures	4 (0+4)	SWCE
19	SEC19	Construction, management and maintenance of protected cultivation structures	4 (0+4)	REE
20	SEC20	Agro processing methods, equipment operation and maintenance	4 (0+4)	PFE
21	SEC21	Operation and management of multi- commodity agro-processing centre	4 (0+4)	PFE
22	SEC22	Primary processing and value addition and cold chain logistics	4 (0+4)	PFE
23	SEC23	Food grain godown and warehouse management	4 (0+4)	PFE
24	SEC24	Post-harvest value chain management including logistics	4 (0+4)	PFE

SEMESTER-2

Sr. No.	Course Name	Course No.	Credit	L	P	T
1	Operation and maintenance of farm machinery	SEC1	4 (0+4)	0	4	4

Objective

To enable the students to acquire basic skills in operation and maintenance of farm machinery so that skill for employment and entrepreneurship may be developed.

Practical

Constructional details, adjustment and working of primary tillage equipment such as mould board plough and disc plough, Constructional details, adjustment and working of secondary tillage equipment such as cultivators, harrows, Constructional details, adjustment and working of weeding equipment such as manual weeder, power weeder/ dry land weeders/ low land weeders/ interculture equipment, Constructional details, adjustment and working of rotary tillage / active tillage equipment such as tractor operated /power tiller operated rotavator, Constructional details, adjustment and working of sowing equipment such as seed drills, planters and transplanters, minimum tillage equipment, Adjustments and calibration of seed drills, Working with different types of furrow openers with seed drills/ planters, Constructional details, adjustment and working of metering mechanisms of drills and planters, Details of precision farm equipment such as laser

levelers, zero till drills, pneumatic planters etc., Constructional details, adjustment and working with earth moving equipment such as bulldozers, trenchers and elevators, etc., Constructional details, adjustment and working of transplanting equipment such as rice transplanters and vegetable transplanters, Seedling raising technique for transplanters, Constructional details, adjustment and working of irrigation equipment such as different types of pumps, sprinkler irrigation system/drip irrigation system, Constructional details, adjustment and working of harvesting equipment such as root crop harvesters (bullock drawn as well as tractor operated groundnut diggers) and grain crop harvesters (self-propelled / tractor operated/ power tiller operated vertical conveyer reapers) etc., Constructional Details, adjustment and working of threshing equipment such as axial flow paddy threshers, combine harvesters etc.

Planning of Practical		
Sr. No	Topics to be covered in Practical	No. of Practical
1.	Constructional details, adjustment and working of primary tillage equipment such as mould board plough and disc plough	5
2.	Constructional details, adjustment and working of secondary tillage equipment such as cultivators, harrows	5
3.	Constructional details, adjustment and working of weeding equipment such as manual weeder, power weeder/ dry land weeders/ low land weeders/ interculture equipment	4
4.	Constructional details, adjustment and working of rotary tillage / active tillage equipment such as tractor operated /power tiller operated rotavator	4
5.	Constructional details, adjustment and working of sowing equipment such as seed drills, planters and transplanters, minimum tillage equipment	5
6.	Adjustments and calibration of seed drills	4
7.	Working with different types of furrow openers with seed drills/ planters	4
8.	Constructional details, adjustment and working of metering mechanisms of drills and planters	5
9.	Details of precision farm equipment such as laser levelers, zero till drills, pneumatic planters etc.	5
10.	Constructional details, adjustment and working with earth moving equipment such as bulldozers, trenchers and elevators, etc.	4
11.	Constructional details, adjustment and working of transplanting equipment such as rice transplanters and vegetable transplanters, Seedling raising technique for transplanters	5
12.	Constructional details, adjustment and working of irrigation equipment such as different types of pumps, sprinkler irrigation system/drip irrigation system	4
13.	Constructional details, adjustment and working of harvesting equipment such as root crop harvesters (bullock drawn as well as tractor operated groundnut diggers) and grain crop harvesters (self-propelled / tractor operated/ power tiller operated vertical conveyer reapers) etc.	5
14.	Constructional Details, adjustment and working of threshing equipment such as axial flow paddy threshers, combine harvesters etc.	5
Total		64

SEMESTER-2

Sr. No.	Course Name	Course No.	Credit	L	P	T
2	Repair and maintenance of tractors and power tillers	SEC2	4 (0+4)	0	4	4

Objective

To enable the students to acquire basic skills in repair and maintenance of tractors and power tillers so that skill for employment and entrepreneurship may be developed.

Practical

Study of different systems of tractor and power tiller, Study of different components of engine: piston, cylinder, rings, fly wheel, firing interval, firing order, Study of fuel system, working principle, repair and maintenance, Working of fuel pumps, fuel filters and injectors, Study of lubrication system, working principle, repair and maintenance, Working of oil filters, oil pumps etc., Study of cooling system, working principle, repair and maintenance, Working of thermostat valve, Study of tractor/ power tiller engine system, Study of power transmission system of tractor/ power tiller (different types of clutches/gears/ sliding mesh gear box/constant mesh gear box/ planetary gear box etc. in tractor; power transmission in power tiller), Study of differential / final drive/ PTO drive, their working principle/ repair and maintenance, Study of braking system: different types of brakes/ their components and working principle/ adjustment / repair, Study of steering system, types of steering system, steering geometry: caster angle, camber angle, toe-in, toe-out etc. working principle, adjustments, repair and maintenance, Steering in power tiller: Dog clutch and other arrangements, Study of hydraulic system of tractor, automatic draft and position control, hitch system, their working principle, practical hitching, repair and maintenance, Study of tyres, rims, their construction and specification, repair and maintenance, Daily, weekly and monthly maintenance schedule. Maintenance after each 50, 125, 250 and 500 hours of operation, Engine overhauling and assembling, Implement hitching and detaching from tractor as well as power tiller, Safety rules.

Planning of Practical		
Sr. No	Topics to be covered in Practical	No. of Practical
1.	Study of different systems of tractor and power tiller	3
2.	Study of different components of engine: piston, cylinder, rings, fly wheel, firing interval, firing order	3
3.	Study of fuel system, working principle, repair and maintenance	3
4.	Study of working of fuel pumps, fuel filters and injectors	3
5.	Study of lubrication system, working principle, repair and maintenance	3
6.	Working of oil filters, oil pumps etc.	3
7.	Study of cooling system, working principle, repair and maintenance	3
8.	Study of working of thermostat valve	3
9.	Study of tractor/ power tiller engine system	3
10.	Study of power transmission system of tractor/ power tiller (different types of clutches/gears/ sliding mesh gear box/constant mesh gear box/ planetary gear box etc. in tractor, power transmission in power tiller)	4
11.	Study of differential / final drive/ PTO drive, their working principle/ repair and maintenance	4
12.	Study of braking system- different types of brakes/ their components and working principle/ adjustment / repair.	3

13.	Study of steering system, types of steering system, steering geometry: caster angle, camber angle, toe-in, toe-out etc. working principle, adjustments, repair and maintenance	4
14.	Study of steering in power tiller- dog clutch and other arrangements	3
15.	Study of hydraulic system of tractor, automatic draft and position control, hitch system, their working principle, practical hitching, repair and maintenance	4
16.	Study of tyres, rims, their construction and specification, repair and maintenance	3
17.	Daily, weekly and monthly maintenance schedule. Maintenance after each 50, 125, 250 and 500 hours of operation	3
18.	Study of engine overhauling and assembling.	3
19.	Study of implement hitching and detaching from tractor as well as power tiller	4
20.	Familiarization with safety rules	2
Total		64

SEMESTER-2

Sr. No.	Course Name	Course No.	Credit	L	P	T
3	Management of Agricultural Machinery Custom Hiring and Maintenance Facilities	SEC3	4 (0+4)	0	4	4

Objective

To enable the students to acquire basic skills in repair and maintenance of tractors and power tillers so that skill for employment and entrepreneurship may be developed.

Practical

Terms associated with machinery management for correct understanding, Different ways machinery can be obtained for use on the farm, Factors that affect the purchase of machinery, Advantages and limitations of two-wheel drive tractors, Advantages and limitations of four-wheel drive tractors, Calculation of the theoretical capacity of a farm machines, General rules concerning field efficiency, Calculation of field capacity of a farm machines, Distinguishing between types of costs of machinery ownership, Understanding how cost and machine use are related, Calculation of salvage value of a farm machine, Calculation of average machine investment of a farm machine, Calculation of annual fixed cost of a farm machine, Calculation of repair cost for a farm machine, Calculation of fuel and lubrication costs for a tractor, Calculation of labor cost for a farm machine, Understanding causes of fatal tractor accidents, Learning of procedures for safe machine operation, Understanding the reasons for efficiency in tractor operation, Preventative maintenance of farm Machinery, List five areas of servicing machinery, Calculate estimated variable cost of a farm machine, Calculate overall cost per acre for farm machinery, Calculate equipment width (size) to match tractor horsepower.

Planning of Practical		
Sr. No	Topics to be covered in Practical	No. of Practical
1.	Terms associated with machinery management for correct understanding	3
2.	Different ways machinery can be obtained for use on the farm	3

3.	Factors that affect the purchase of machinery	2
4.	Advantages and limitations of two-wheel drive tractors	3
5.	Advantages and limitations of four-wheel drive tractors	3
6.	Calculation of the theoretical capacity of a farm machines	3
7.	General rules concerning field efficiency	2
8.	Calculation of field capacity of a farm machines	3
9.	Distinguishing between types of costs of machinery ownership	2
10.	Understanding how cost and machine use are related	3
11.	Calculation of salvage value of a farm machine	2
12.	Calculation of average machine investment of a farm machine	3
13.	Calculation of annual fixed cost of a farm machine	3
14.	Calculation of repair cost for a farm machine	2
15.	Calculation of fuel and lubrication costs for a tractor	2
16.	Calculation of labor cost for a farm machine	3
17.	Understanding causes of fatal tractor accidents	3
18.	Learning of procedures for safe machine operation	3
19.	Understanding the reasons for efficiency in tractor operation	3
20.	Preventative maintenance of farm Machinery	3
21.	List five areas of servicing machinery	2
22.	Calculation of estimated variable cost of a farm machine	3
23.	Calculation of overall cost per acre for farm machinery	3
24.	Calculation of equipment width (size) to match tractor horsepower	2
Total		64

SEMESTER-2

Sr. No.	Course Name	Course No.	Credit	L	P	T
4	Fabrication, Operation and Maintenance of Renewable Energy devices	SEC4	4 (0+4)	0	4	4

- Acquaintance with different renewable energy sources (solar, wind, hydro, biomass, geothermal).
- Principles of photovoltaic (PV) technology, fabrication processes for solar panels & Installation and maintenance of solar power systems.
- Grid-tied vs. off-grid solar systems.
- Wind turbine technology and components, fabrication and installation of wind turbines., operation and maintenance practices for wind farms.
- Pico hydro and their construction and maintenance
- Biomass sources and conversion technologies (combustion, gasification, anaerobic digestion).
- Fabrication of biomass energy systems like gasifier, Improved chullah, etc.
- Routine maintenance procedures for renewable energy systems, Troubleshooting common issues.
- Safety protocols for maintenance tasks; Monitoring and performance optimization.
- Real-world examples of successful renewable energy projects, Hands-on projects to reinforce learning.
- Acquaintance with the emerging trends in renewable energy, exploration of innovative technologies (tidal, wave, solar thermal, etc.).

- Renewable energy policies and incentives, regulatory compliance for renewable energy projects, environmental considerations and permitting processes.

Planning of Practical		
Sr. No	Topics to be covered in Practical	No. of Practical
1.	Acquaintance with different renewable energy sources (solar, wind, hydro, biomass, geothermal).	5
2.	Principles of photovoltaic (PV) technology, fabrication processes for solar panels & Installation and maintenance of solar power systems	5
3.	Grid-tied vs. off-grid solar systems	4
4.	Wind turbine technology and components, fabrication and installation of wind turbines., operation and maintenance practices for wind farms	5
5.	Pico hydro and their construction and maintenance	5
6.	Biomass sources and conversion technologies (combustion, gasification, anaerobic digestion)	5
7.	Fabrication of biomass energy systems like gasifier, Improved chullah, etc	5
8.	Routine maintenance procedures for renewable energy systems, Troubleshooting common issues	6
9.	Safety protocols for maintenance tasks; Monitoring and performance optimization	5
10.	Real-world examples of successful renewable energy projects, Hands-on projects to reinforce learning	6
11.	Acquaintance with the emerging trends in renewable energy, exploration of innovative technologies (tidal, wave, solar thermal, etc.).	6
12.	Renewable energy policies and incentives, regulatory compliance for renewable energy projects, environmental considerations and permitting processes	6
Total		64

SEMESTER-2

Sr. No.	Course Name	Course No.	Credit	L	P	T
5	Operation and Maintenance of Drones Used for Agricultural Applications	SEC5	4 (0+4)	0	4	4

Objective

To enable the students to acquire basic skills in operation and maintenance of drones used for agricultural applications so that skill for employment and entrepreneurship may be developed.

Practical

Overview of drone technology, Importance of drones in agriculture. Types of agricultural drones (fixed-wing, rotary-wing, multi-rotor), Regulatory framework and compliance requirements for agricultural drone operations, Understanding the components of a drone (frame, motors, propellers, flight controller, sensors, etc.), functionality of each component and its role in drone operation, basics of drone aerodynamics and flight principles, Introduction to various sensors

used in agricultural drones (RGB cameras, multispectral cameras, thermal cameras, LiDAR, etc.), Applications of different sensors in agriculture (crop monitoring, pest detection, irrigation management, etc.), Payload integration and compatibility considerations, Principles of flight planning for agricultural drone missions, Selection of appropriate flight parameters (altitude, speed, overlap, etc.), Use of mission planning software and tools, Pre-flight checks and safety protocols, Techniques for data acquisition during drone flights, Post-flight data processing and analysis, Interpretation of aerial imagery and sensor data, Software tools for data processing and visualization, Applications of drones in crop monitoring (plant health assessment, yield estimation, disease detection, etc.), Integration of drone data with precision agriculture techniques; Decision support systems for crop management based on drone data, Using drones for early pest and disease detection, Identification of common pests and diseases in crops, Monitoring strategies for pest infestations and disease outbreaks, Role of drones in assessing soil moisture levels and irrigation needs, Optimizing irrigation scheduling with drone data, Water resource management and conservation using drone technology, Routine maintenance procedures for agricultural drones, Diagnosing and troubleshooting common issues (motor failure, GPS signal loss, sensor calibration, etc.), Battery management and care, Safety protocols for drone operations in agricultural settings, Understanding airspace regulations and restrictions, Emergency procedures and risk mitigation strategies, Real-world examples of successful drone applications in agriculture, Hands-on exercises and field demonstrations, Challenges and opportunities for the widespread adoption of drone technology in agriculture, Ethical and societal implications of drone use in farming.

Planning of Practical		
Sr. No	Topics to be covered in Practical	No. of Practical
1.	Overview of drone technology, Importance of drones in agriculture. Types of agricultural drones (fixed-wing, rotary-wing, multi-rotor), Regulatory framework and compliance requirements for agricultural drone operations	5
2.	Understanding the components of a drone (frame, motors, propellers, flight controller, sensors, etc.), functionality of each component and its role in drone operation, basics of drone aerodynamics and flight principles	5
3.	Introduction to various sensors used in agricultural drones (RGB cameras, multispectral cameras, thermal cameras, LiDAR, etc.)	4
4.	Applications of different sensors in agriculture (crop monitoring, pest detection, irrigation management, etc.), Payload integration and compatibility considerations	5
5.	Principles of flight planning for agricultural drone missions, Selection of appropriate flight parameters (altitude, speed, overlap, etc.), Use of mission planning software and tools, Pre-flight checks and safety protocols	5
6.	Techniques for data acquisition during drone flights, Post-flight data processing and analysis, Interpretation of aerial imagery and sensor data, Software tools for data processing and visualization	5
7.	Applications of drones in crop monitoring (plant health assessment, yield estimation, disease detection, etc.), Integration of drone data with precision agriculture techniques; Decision support systems for crop management based on drone data	5
8.	Using drones for early pest and disease detection, Identification of common pests and diseases in crops, Monitoring strategies for pest infestations and disease outbreaks	5

9.	Role of drones in assessing soil moisture levels and irrigation needs, Optimizing irrigation scheduling with drone data, Water resource management and conservation using drone technology	5
10.	Routine maintenance procedures for agricultural drones, Diagnosing and troubleshooting common issues (motor failure, GPS signal loss, sensor calibration, etc.), Battery management and care	5
11.	Safety protocols for drone operations in agricultural settings, Understanding airspace regulations and restrictions, Emergency procedures and risk mitigation strategies	5
12.	Real-world examples of successful drone applications in agriculture, Hands-on exercises and field demonstrations	5
13.	Challenges and opportunities for the widespread adoption of drone technology in agriculture, Ethical and societal implications of drone use in farming	5
Total		64

SEMESTER-2

Sr. No.	Course Name	Course No.	Credit	L	P	T
6	Machine vision, sensors and sensors architecture	SEC6	4 (0+4)	0	4	4

Objective

To enable the students to acquire basic skills in machine vision, sensors and sensors architecture used for agricultural applications so that skill for employment and entrepreneurship may be developed.

Practical

Overview of machine vision systems and their applications, Importance of sensors in machine vision, Basic principles of image processing and analysis. Classification of sensors based on various criteria (type of measurement, operating principle, etc.), Overview of common sensor types: optical sensors, proximity sensors, temperature sensors, pressure sensors, etc. Comparison of different sensor technologies in terms of accuracy, response time, cost, and suitability for specific applications. Components of a sensor system (sensor element, signal conditioning circuitry, interface electronics, etc.). Sensor characteristics: sensitivity, resolution, linearity, hysteresis, etc. Considerations in sensor selection and integration for specific applications. Basics of image acquisition: sensors, lenses, lighting, Image processing techniques: filtering, edge detection, segmentation, feature extraction, etc., Role of algorithms in image analysis and interpretation. Components and architecture of a typical machine vision system, Integration of sensors and vision systems for industrial automation and quality control. Applications of machine vision in various industries (manufacturing, automotive, pharmaceuticals, etc.). Principles of 3D vision and depth sensing technologies, Types of 3D sensors: stereo vision, structured light, time-of-flight, etc. Applications of 3D vision in robotics, metrology, object recognition, etc. Examples of multisensor systems in real-world applications. Overview of smart sensors and their capabilities (self-calibration, self-diagnosis, etc.), Integration of sensors into IoT (Internet of Things) platforms. Case studies of IoT applications in agriculture. Introduction to sensor networks, Communication protocols for sensor networks (Bluetooth, Zigbee, LoRaWAN, etc.). Basics of embedded vision systems, Integration of sensors and vision processing capabilities into embedded systems. Applications of embedded vision in autonomous vehicles, drones, consumer

electronics, etc. Real-world examples of sensor systems and machine vision applications, Hands-on exercises and projects involving sensor integration and image processing, Industry visits or guest lectures from professionals working in the field. Emerging trends in sensor technology and machine vision, Challenges in developing advanced sensor systems (miniaturization, power efficiency, cost reduction, etc.), Ethical and societal implications of widespread sensor deployment and data collection.

Planning of Practical		
Sr. No	Topics to be covered in Practical	No. of Practical
1.	Overview of machine vision systems and their applications, Importance of sensors in machine vision, Basic principles of image processing and analysis	5
2.	Classification of sensors based on various criteria (type of measurement, operating principle, etc.), Overview of common sensor types: optical sensors, proximity sensors, temperature sensors, pressure sensors, etc.	5
3.	Comparison of different sensor technologies in terms of accuracy, response time, cost, and suitability for specific applications	3
4.	Components of a sensor system (sensor element, signal conditioning circuitry, interface electronics, etc.)	4
5.	Sensor characteristics: sensitivity, resolution, linearity, hysteresis, etc.	3
6.	Considerations in sensor selection and integration for specific applications	2
7.	Basics of image acquisition: sensors, lenses, lighting, Image processing techniques: filtering, edge detection, segmentation, feature extraction, etc., Role of algorithms in image analysis and interpretation	5
8.	Components and architecture of a typical machine vision system, Integration of sensors and vision systems for industrial automation and quality control	3
9.	Applications of machine vision in various industries (manufacturing, automotive, pharmaceuticals, etc.)	3
10.	Principles of 3D vision and depth sensing technologies, Types of 3D sensors: stereo vision, structured light, time-of-flight, etc.	3
11.	Applications of 3D vision in robotics, metrology, object recognition, etc.	2
12.	Examples of multisensor systems in real-world applications	3
13.	Overview of smart sensors and their capabilities (self-calibration, self-diagnosis, etc.), Integration of sensors into IoT (Internet of Things) platforms	
14.	Case studies of IoT applications in agriculture	3
15.	Introduction to sensor networks, Communication protocols for sensor networks (Bluetooth, Zigbee, LoRaWAN, etc.)	3
16.	Basics of embedded vision systems, Integration of sensors and vision processing capabilities into embedded systems	3
17.	Applications of embedded vision in autonomous vehicles, drones, consumer electronics, etc.	4
18.	Real-world examples of sensor systems and machine vision applications, Hands-on exercises and projects involving sensor integration and image processing, Industry visits or guest lectures from professionals working in the field	5
19.	Emerging trends in sensor technology and machine vision, Challenges in developing advanced sensor systems (miniaturization, power efficiency, cost reduction, etc.), Ethical and societal implications of widespread sensor	5

	deployment and data collection	
	Total	64

SEMESTER – 2

Sr. No.	Course Name	Course No.	Credit	L	P	T
7	Design of Solar PV Systems Using Softwares	SEC7	4(0+4)	0	4	4

Practical Topics:

- Overview of software tools commonly used for solar PV system design (e.g., PV*SOL, Helioscope, PVSyst, SAM), Purpose and capabilities of each software tool, Installation and setup instructions for the selected softwares.
- Features for designing a solar PV system (location, load requirements, shading analysis, etc.), Gathering necessary input data: site location, solar irradiance data, system specifications, electrical load profile, etc.
- Conducting a site analysis to assess the solar potential and available space for PV system installation, Using software tools to perform shading analysis and identify potential obstructions or shading issues.
- Determining the appropriate size of the solar PV system, Selecting PV modules, inverters, mounting structures, and other system components. Optimizing the system configuration to maximize energy production and efficiency
- Creating a layout for the solar PV array using the software's design tools, Placing PV modules on the roof or ground in optimal orientations and configurations.
- Designing the electrical wiring and connection scheme for the PV array, inverters, and other components.
- Running simulations to estimate the performance and energy yield of the proposed PV system, Analyzing simulation results to evaluate the system's energy production, capacity factor, and financial viability.
- Fine-tuning system parameters to optimize performance and maximize energy output.
- Performing a financial analysis to assess the economic feasibility of the solar PV project, Calculating the return on investment (ROI), payback period, net present value (NPV), and other financial metrics , Considering incentives, subsidies, and financing options for solar PV installations.
- Conducting sensitivity analysis to evaluate the impact of variations in key parameters (e.g., module efficiency, system size, electricity tariffs) on project economics, Iteratively refining the system design to achieve the desired performance and economic outcomes.
- Generating detailed reports and documentation summarizing the design process, simulation results, and project economics
- Case studies based on real-world projects to apply learned concepts and techniques.
- Addressing common challenges and troubleshooting issues encountered during the design process.

Planning of Practical		
Sr. No	Topics to be covered in Practical	No. of Practical
1.	Overview of software tools commonly used for solar PV system design (e.g., PV*SOL, Helioscope, PVSyst, SAM),	2
2.	Purpose and capabilities of each software tool, Installation and setup instructions for the selected softwares.	3
3.	Features for designing a solar PV system (location, load requirements, shading analysis, etc.),	2
4.	Gathering necessary input data: site location, solar irradiance data, system specifications, electrical load profile, etc.	2
5.	Conducting a site analysis to assess the solar potential and available space for PV system installation, Using software tools to perform shading analysis and identify potential obstructions or shading issues.	3
6.	Determining the appropriate size of the solar PV system, Selecting PV modules, inverters, mounting structures, and other system components.	2
7.	Optimizing the system configuration to maximize energy production and efficiency.	2
8.	Creating a layout for the solar PV array using the software's design tools, Placing PV modules on the roof or ground in optimal orientations and configurations.	2
9.	Designing the electrical wiring and connection scheme for the PV array, inverters, and other components.	3
10.	Running simulations to estimate the performance and energy yield of the proposed PV system.	2
11.	Analyzing simulation results to evaluate the system's energy production.	2
12.	Analyzing simulation results to evaluate the system's Capacity factor.	2
13.	Analyzing simulation results to evaluate the system's financial viability.	2
14.	Fine-tuning system parameters to optimize performance and maximize energy output.	2
15.	Performing a financial analysis to assess the economic feasibility of the solar PV project.	2
16.	Calculating the return on investment (ROI), payback period, net present value (NPV).	2
17.	Calculating the financial metrics , Considering incentives.	2
18.	Calculating the subsidies, and financing options for solar PV installations.	2
19.	Conducting sensitivity analysis to evaluate the impact of variations in key parameters (e.g., module efficiency) on project economics, Iteratively refining the system design to achieve the desired performance and economic outcomes.	3
20.	Conducting sensitivity analysis to evaluate the impact of variations in key parameters (e.g., system size) on project economics, Iteratively refining the system design to achieve the desired performance and economic outcomes.	3
21.	Conducting sensitivity analysis to evaluate the impact of variations in key parameters (e.g., electricity tariffs) on project economics, Iteratively refining the system design to achieve the desired performance and economic outcomes.	3
22.	Generating detailed reports and documentation summarizing the design	4

	process, simulation results, and project economics	
23.	Case studies based on real-world projects to apply learned concepts and techniques.	4
24.	Addressing common challenges and troubleshooting issues encountered during the design process.	4
Total		60

SEMESTER – 2

Sr. No.	Course Name	Course No.	Credit	L	P	T
8	Installation and Maintenance of On-Grid and Off-Grid Solar Systems	SEC8	4(0+4)	0	4	4

Practical Topics:

- Overview of solar photovoltaic technology and its applications, Explanation of on-grid and off- grid solar systems.
- Identification and explanation of key components in solar PV systems (solar panels, inverters, charge controllers, batteries, wiring, etc.).
- Understanding the differences between on-grid and off-grid system configurations.
- Component identification and system layout design.
- Conducting site assessments to determine solar potential and suitability for PV system installation. Considerations for system sizing, orientation, and tilt angle, Planning the layout of solar panels, mounting structures, and electrical components.
- Installation of solar panels, inverters, and other components for on-grid systems, Techniques for mounting solar panels on rooftops or ground-mounted structures.
- Wiring and connection of components to the electrical grid.
- Setting up off-grid solar systems, including battery-based energy storage, Installation of charge controllers, batteries, and DC loads.
- Designing and configuring off-grid systems for reliable and efficient operation.
- Electrical wiring practices for solar PV systems.
- Understanding safety precautions and regulations related to electrical installations.
- Wiring solar panels, inverters, charge controllers, and battery banks.
- Commissioning and testing of solar PV systems to ensure proper functionality, Conducting performance tests and verifying system parameters.
- Troubleshooting common issues and addressing installation errors.
- Routine maintenance tasks for on-grid solar PV systems, including cleaning, inspection, and performance monitoring, Diagnosis and troubleshooting of grid-connected system components.
- Specialized maintenance requirements for off-grid solar systems, including battery maintenance and charge controller calibration.
- Techniques for integrating additional solar panels, batteries, or other components into existing systems.
- System modification and expansion.
- Introduction to remote monitoring systems for tracking the performance of solar PV systems, Using data analytics tools to diagnose issues and optimize system performance, Hands-on practice in accessing system data and interpreting performance metrics.

Planning of Practical		
Sr. No	Topics to be covered in Practical	No. of Practical
1.	Overview of solar photovoltaic technology and its applications.	2
2.	Explanation of on-grid and off- grid solar systems.	2
3.	Identification and explanation of key components in solar PV systems (solar panels, inverters, charge controllers, batteries, wiring, etc.).	4
4.	Understanding the differences between on-grid and off-grid system configurations.	2
5.	Component identification and system layout design.	2
6.	Conducting site assessments to determine solar potential and suitability for PV system installation.	2
7.	Considerations for system sizing, orientation, and tilt angle, Planning the layout of solar panels, mounting structures, and electrical components.	3
8.	Installation of solar panels, inverters, and other components for on-grid systems.	2
9.	Techniques for mounting solar panels on rooftops or ground-mounted structures.	2
10.	Wiring and connection of components to the electrical grid.	2
11.	Setting up off-grid solar systems, including battery-based energy storage,	2
12.	Installation of charge controllers, batteries, and DC loads.	4
13.	Designing and configuring off-grid systems for reliable and efficient operation.	2
14.	Electrical wiring practices for solar PV systems.	4
15.	Understanding safety precautions and regulations related to electrical installations.	2
16.	Wiring solar panels, inverters, charge controllers, and battery banks.	2
17.	Commissioning and testing of solar PV systems to ensure proper functionality.	2
18.	Conducting performance tests and verifying system parameters.	2
19.	Troubleshooting common issues and addressing installation errors.	2
20.	Routine maintenance tasks for on-grid solar PV systems, including cleaning, inspection, and performance monitoring, Diagnosis and troubleshooting of grid-connected system components.	4
21.	Specialized maintenance requirements for off-grid solar systems, including battery maintenance and charge controller calibration.	2
22.	Techniques for integrating additional solar panels, batteries, or other components into existing systems.	2
23.	System modification and expansion.	2
24.	Introduction to remote monitoring systems for tracking the performance of solar PV systems, Using data analytics tools to diagnose issues and optimize system performance.	4
25.	Hands-on practice in accessing system data and interpreting performance metrics.	2
Total		61

SEMESTER – 2 (SKILL ENHANCEMENT COURSE)

Sr. No.	Course Name	Course No.	Credit	L	P	T
9	Design and Maintenance of Agrivoltaic Systems	SEC9	4 (0+4)	0	4	4

Practical Topics:

- Overview of agrivoltaic systems and their benefits, Explanation of how solar panels and agriculture can coexist synergistically.
- Factors to consider when selecting a site for an agrivoltaic system (climate, soil, topography, etc.), Conducting site assessments to determine solar potential and suitability for agricultural activities.
- Design principles for integrating solar panels with agricultural crops or livestock, Planning the layout and configuration of the agrivoltaic system to maximize energy production and crop yield.
- Selection of appropriate crops and planting strategies for agrivoltaic systems.
- Installation of solar panels on support structures (ground-mounted or elevated) with proper panel orientation and tilt angle for maximum energy capture.
- Safety protocols and best practices for working with solar panel arrays.
- Crop selection and management practices suitable for agrivoltaic systems, Monitoring soil moisture, nutrient levels, and crop health.
- Implementing irrigation, fertilization, and pest management strategies tailored to agrivoltaic conditions.
- Designing the electrical layout for connecting solar panels to the grid or off-grid systems, Installation of wiring, inverters, combiner boxes, and other electrical components, Compliance with electrical codes and safety standards.
- Routine maintenance tasks for solar panels, support structures, and electrical components, Monitoring system performance and troubleshooting common issues, equipment inspection, cleaning, and maintenance.
- Introduction to data monitoring systems for tracking energy production, crop yield, and environmental conditions, Interpretation of data to optimize system performance and agricultural productivity, using data analytics tools to identify trends and patterns.
- Overview of regulations, permits, and incentives related to agrivoltaic installations, Compliance with zoning laws, land use regulations, and environmental regulations, Advocacy for supportive policies and incentives to encourage the adoption of agrivoltaics.
- Visits to agrivoltaic installations and research sites for hands-on learning opportunities, Practical demonstrations of agrivoltaic techniques and technologies, Interaction with practitioners and experts in the field.

Planning of Practical		
Sr. No	Topics to be covered in Practical	No. of Practical
1.	Overview of agrivoltaic systems and their benefits.	2
2.	Explanation of how solar panels and agriculture can coexist	2

	synergistically.	
3.	Factors to consider when selecting a site for an agrivoltaic system (climate, soil, topography, etc.).	2
4.	Conducting site assessments to determine solar potential and suitability for agricultural activities.	4
5.	Design principles for integrating solar panels with agricultural crops or livestock.	4
6.	Planning the layout and configuration of the agrivoltaic system to maximize energy production and crop yield.	2
7.	Selection of appropriate crops and planting strategies for agrivoltaic systems.	2
8.	Installation of solar panels on support structures (ground-mounted or elevated) with proper panel orientation and tilt angle for maximum energy capture.	4
9.	Safety protocols and best practices for working with solar panel arrays.	4
10.	Crop selection and management practices suitable for agrivoltaic systems, Monitoring soil moisture, nutrient levels, and crop health.	3
11.	Implementing irrigation, fertilization, and pest management strategies tailored to agrivoltaic conditions	3
12.	Designing the electrical layout for connecting solar panels to the grid or off-grid systems.	3
13.	Installation of wiring, inverters, combiner boxes, and other electrical components, Compliance with electrical codes and safety standards.	2
14.	Routine maintenance tasks for solar panels, support structures, and electrical components, Monitoring system performance and troubleshooting common issues, equipment inspection, cleaning, and maintenance.	4
15.	Introduction to data monitoring systems for tracking energy production, crop yield, and environmental conditions,	3
16.	Interpretation of data to optimize system performance and agricultural productivity, using data analytics tools to identify trends and patterns.	4
17.	Overview of regulations, permits, and incentives related to agrivoltaic installations.	3
18.	Compliance with zoning laws, land use regulations, and environmental regulations, Advocacy for supportive policies and incentives to encourage the adoption of agrivoltaics.	3
19.	Visits to agrivoltaic installations and research sites for hands-on learning opportunities,	3
20.	Practical demonstrations of agrivoltaic techniques and technologies, Interaction with practitioners and experts in the field.	4
Total		61

SEMESTER – 2 (SKILL ENHANCEMENT COURSE)

Sr. No.	Course Name	Course No.	Credit	L	P	T
10	Valorization of Agri-biomass and	SEC10	4 (0+4)	0	4	4

	Organic Waste					
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Practical Topics:

- Concept of valorization and its role in waste-to-value processes, Introduction to the types of agri-biomass and organic waste commonly generated in agriculture and food production.
- Methods for characterizing agri-biomass and organic waste (composition, moisture content, calorific value, etc.), Understanding the properties and potential uses of different types of biomass and waste materials.
- Sample collection, preparation, and analysis.
- Introduction to biological conversion methods such as anaerobic digestion and composting, Principles of microbial decomposition and fermentation in biomass conversion.
- Overview of thermochemical conversion techniques including pyrolysis, gasification, and hydrothermal processing, Understanding the principles of heat transfer, chemical reactions, and product formation in thermochemical processes.
- Introduction to biochemical and biotechnological approaches for valorizing biomass and organic waste, Utilization of enzymes, microorganisms, and fermentation processes in bioconversion
- Methods for producing biofuels from agri-biomass and organic waste (biogas, biodiesel, bioethanol, etc.).
- Valorization of agri-biomass and organic waste into value-added products such as biochar, bio- based chemicals, and biomaterials,
- Strategies for waste minimization, reuse, and recycling in agricultural and food production systems.
- Emerging trends such as agri-biomass and organic waste valorization technologies, precision biomass conversion and integrated bio-refinery concepts.
- Overview of regulations, standards, and policies governing the valorization of agri-biomass and organic waste.

Planning of Practical		
Sr. No	Topics to be covered in Practical	No. of Practical
1.	Concept of valorization and its role in waste-to-value processes.	4
2.	Introduction to the types of agri-biomass and organic waste commonly generated in agriculture and food production.	4
3.	Methods for characterizing agri-biomass and organic waste (composition, moisture content, calorific value, etc.).	4
4.	Understanding the properties and potential uses of different types of biomass and waste materials.	4
5.	Sample collection, preparation, and analysis.	4
6.	Introduction to biological conversion methods such as anaerobic digestion and composting,	4
7.	Principles of microbial decomposition and fermentation in biomass	4

	conversion.	
8.	Overview of thermochemical conversion techniques including pyrolysis, gasification, and hydrothermal processing,	4
9.	Understanding the principles of heat transfer, chemical reactions, and product formation in thermochemical processes.	4
10.	Introduction to biochemical and biotechnological approaches for valorizing biomass and organic waste, Utilization of enzymes, microorganisms, and fermentation processes in bioconversion	4
11.	Methods for producing biofuels from agri-biomass and organic waste (biogas, biodiesel, bioethanol, etc.).	4
12.	Valorization of agri-biomass and organic waste into value-added products such as biochar, bio- based chemicals, and biomaterials,	4
13.	Strategies for waste minimization, reuse, and recycling in agricultural and food production systems.	4
14.	Emerging trends such as agri-biomass and organic waste valorization technologies, precision biomass conversion and integrated bio-refinery concepts.	4
15.	Overview of regulations, standards, and policies governing the valorization of agri-biomass and organic waste.	4
Total		60

SEMESTER – 2 (SKILL ENHANCEMENT COURSE)

Sr. No.	Course Name	Course No.	Credit	L	P	T
11	Energy audit, Energy Conservation and Energy Efficiency	SEC11	4 (0+4)	0	4	4

Practical Topics:

- Key concepts and definitions related to energy conservation and efficiency.
- Introduction to the principles of energy auditing and analysis.
- Methods for collecting and analyzing energy consumption data.
- Interpretation of energy bills, utility data, and meter readings.
- Conducting energy audits for residential, commercial, and industrial facilities.
- Introduction to energy auditing tools and equipment (e.g., power meters, data loggers, thermal imaging cameras).
- Use of software tools for energy data analysis and visualization.
- Identifying potential areas for energy savings and efficiency improvements, Evaluation of building systems, equipment, and operations.
- Hands-on exercises in identifying ECOs through site inspections and data analysis.
- Overview of energy-efficient technologies and best practices in lighting, HVAC, insulation, appliances, etc, Demonstration of energy-saving devices and equipment, Case studies of successful energy efficiency projects.
- Analysis of building energy performance using energy modelling software.
- Integration of renewable energy systems (solar PV, wind, geothermal, etc.) with energy conservation and efficiency measures.

- Overview of energy efficiency policies, regulations, and incentives at local, national, and international levels.
- Energy efficiency standards, labeling programs, and building codes.
- Cost-benefit analysis, return on investment (ROI) calculations, and lifecycle cost analysis.
- Use of measurement and verification (M&V) protocols and reporting

Planning of Practical		
Sr. No	Topics to be covered in Practical	No. of Practical
1.	Key concepts and definitions related to energy conservation and efficiency.	4
2.	Introduction to the principles of energy auditing and analysis.	4
3.	Methods for collecting and analyzing energy consumption data.	4
4.	Interpretation of energy bills, utility data, and meter readings.	4
5.	Conducting energy audits for residential, commercial, and industrial facilities.	4
6.	Introduction to energy auditing tools and equipment (e.g., power meters, data loggers, thermal imaging cameras).	4
7.	Use of software tools for energy data analysis and visualization.	4
8.	Identifying potential areas for energy savings and efficiency improvements, Evaluation of building systems, equipment, and operations.	4
9.	Hands-on exercises in identifying ECOs through site inspections and data analysis.	4
10.	Overview of energy-efficient technologies and best practices in lighting, HVAC, insulation, appliances, etc, Demonstration of energy-saving devices and equipment, Case studies of successful energy efficiency projects.	4
11.	Analysis of building energy performance using energy modelling software.	4
12.	Integration of renewable energy systems (solar PV, wind, geothermal, etc.) with energy conservation and efficiency measures.	4
13.	Overview of energy efficiency policies, regulations, and incentives at local, national, and international levels.	4
14.	Energy efficiency standards, labeling programs, and building codes.	4
15.	Cost-benefit analysis, return on investment (ROI) calculations, and lifecycle cost analysis.	4
16.	Use of measurement and verification (M&V) protocols and reporting	4
Total		64

SEMESTER – 2 (SKILL ENHANCEMENT COURSE)

Sr. No.	Course Name	Course No.	Credit	L	P	T
12	Repair and maintenance of pumps and irrigation systems	SEC12	4(0+4)	0	4	4

Repair and maintenance of pumps and irrigation system

- Acquaint with different pumps and motors used in irrigation system
- Study of various water lifting devices and their limitations
- Study of components of centrifugal pump and its function
- Study of components of submersible pump and its function
- Components of reciprocating pump and its function
- Dismantling and assembling of irrigation pumps
- Performance testing of centrifugal pumps
- Preparation of pump housing
- Pump alignment and troubleshooting
- Knowing different accessories for electric pump
- Winding of 3-phase and single phase electric motor
- Causes of trouble shooting in electrical pump set and their remedial measures
- Dismantling and assembling of diesel pump set
- Causes of trouble shooting in diesel pump set and their remedial measures
- Regular maintenance and overhauling, lubrication of pumps
- Study of solar pump set, and its components.
- Stepwise installation of solar pump set including earthing.

Planning of Practicals		
Sr. No	Topics to be covered in Practical	No. of Practical
Acquaint with different pumps and motors used in irrigation system		
1.	Study of positive displacement pump	1
2.	Study of centrifugal pump	1
3.	Study of vertical turbine pump	1
4.	Study of submersible pump	1
Study of various water lifting devices and their limitations		
5.	Study of low head water lifting device and its limitation	1
6.	Study of medium head water lifting device and its limitations	1
7.	Study of high head water lifting device and its limitations	1
Study of components of centrifugal pump and its function		
8.	Study of centrifugal pump housing and its function	1
9.	Study of centrifugal pump impellers and its function	1
10.	Study of accessories used in construction of centrifugal pump	1
Study of components of submersible pump and its function		
11.	Study of construction details of submersible pump	1
12.	Study of various impellers used in construction of submersible pump.	1
13.	Study of electric motor used in submersible pump.	1
Components of reciprocating pump and its function		
14.	Study of various components used in construction of reciprocating pump and its functional details	1
15.	Study of limitation in use of reciprocating pumps	1
Dismantling and assembling of irrigation pumps		
16.	Study on Dismantling and assembling of positive displacement pump.	1
17.	Study on Dismantling and assembling of reciprocating pump	1
18.	Study on Dismantling and assembling of rotary pump	1
19.	Study on Dismantling and assembling of centrifugal pump.	1

20.	Study on Dismantling and assembling of turbine pump.	1
21.	Study on Dismantling and assembling of submersible pump	1
Performance testing of centrifugal pumps		
22.	Performance testing of centrifugal pump connected in series.	1
23.	Performance testing of centrifugal pump connected in parallel.	1
Preparation of pump housing		
24.	Study on design and pattern creation of pump housing	1
25.	Study on mold preparation and metal melting process in pump housing	1
26.	Study on pouring the metal for pump housing	1
27.	Study on cooling and removing the casting	1
28.	Study on cleaning and Finishing the pump housing	1
29.	Study on inspection and testing of pump housing	1
30.	Study on machining and final processing of pump housing	1
Pump alignment and troubleshooting		
31.	Study on checking for misalignment and making adjustments to ensure the pump and motor shafts are properly aligned.	1
32.	Study on pre-alignment check: Inspect the pump and motor, including the baseplates, bearings, seals, and coupling.	1
33.	Study on vibration analysis: Compare the vibration levels of the machinery to established norms to identify anomalies.	1
34.	Study on use of thermography: Identify abnormally hot locations in the machinery to detect misalignment.	1
35.	Study on final adjustments during alignment : Move the movable machine horizontally and vertically to achieve the desired alignment.	1
Knowing different accessories for electric pump		
36.	Study on different foot valves	1
37.	Study on different quick couplings.	1
38.	Study on Electric control panes	1
Winding of 3-phase and single phase electric motor		
39.	Study on winding of 3-phase electric motor	1
40.	Study on single phase electric motor	1
Causes of trouble shooting in electrical pump set and their remedial measures		
41.	Study on cavitation and their remedial measures.	1
42.	Study on Overheating and their remedial measures.	1
43.	Study on Wiring faults and their remedial measures.	1
44.	Study on Motor issues and their remedial measures	1
45.	Study on Insufficient suction pressure and their remedial measures.	1
46.	Study on Reversed impeller rotation and their remedial measures.	1
Dismantling and assembling of diesel pump set		
47.	Study on dismantling the pump set i.e. removing the top cove, impeller, pump body delivery valve, plunger guide, spring sets and plunger.	1
48.	Study on assembling the diesel pump sets	1
49.	Study on realignment of diesel pump set	1
Causes of trouble shooting in diesel pump set and their remedial measures		
50.	Study on causes of fuel contamination, its symptoms in diesel pump set and its remedial measures.	1
51.	Study on causes of Overheating, its symptoms in diesel pump set and its remedial measures.	1

52.	Study on causes of Overheating, its symptoms in diesel pump set and its remedial measures.	1
53.	Study on causes of fuel injection issues and its remedial measures	1
Regular maintenance and overhauling, lubrication of pumps		
54.	Study on regular maintenance of pump including lubrication, cleaning, inspection, and its alignment.	1
55.	Study on inspection for leaks in lines and fittings.	1
56.	Study on checking the vibration levels and investigate any excessive vibrations	1
57.	Study on alignment with driver motor and making necessary adjustment.	1
Study of solar pump set and its components		
58.	Study on Solar panels: Capture sunlight and convert it into electricity needed for pumping systems	1
59.	Study on pump and pump controller used in solar pumping system.	1
60.	Study on piping and other accessories used in solar pumping systems.	1
61.	Study on PV solar panels for generation of electricity used for pumping the water from the sources.	1
Stepwise installation of solar pump set including earthing		
62.	Study on site survey for installation of solar pumping system.	1
63.	Study on calculation of water and power requirement	1
64.	Study on selection of solar pump components	1
65.	Study on mount structure and its installation in solar pumping system.	1
66.	Study on installation of solar PV arrays.	1
67.	Study on installation of pump set, piping systems and wiring systems used in solar pump.	1
Total		67

SEMESTER – 2 (SKILL ENHANCEMENT COURSE)

Sr. No.	Course Name	Course No.	Credit	L	P	T
13	Installation and maintenance of micro irrigation systems	SEC13	4 (0+4)	0	4	4

Practical topics:

- Acquaint with different components of micro irrigation .
- Installing of micro irrigation (both drip and micro sprinkler) system
- Design of micro Irrigation system(both drip and micro irrigation) in field
- Computation crop water requirement of crops
- Acquaint with fertigation equipment, their operation and maintenance
- Execution of fertigation with water soluble fertilizers
- Fixation of fertigation equipment with micro irrigation system
- Doing maintenance schedule in micro irrigation.

- Operating automated micro irrigation system
- Operating IOT based irrigation system

Practical

Planning of Practical		
S.No.	Topics	Proposed No. of Practical
1	Acquaint with different components of pumping system	1
2	Acquaint with different water conveyance system	1
3	Acquaint with different components of sprinkler irrigation system	1
4	Acquaint with different components of drip irrigation system	1
5	Acquaint with different components of mini sprinkler irrigation system	1
6	Acquaint with different components of micro sprinkler irrigation system	1
7	Design of pumping unit for MIS	1
8	Design of conveyance pipe for pressurised MIS	1
9	Design of sprinkler irrigation system	2
10	Design of drip irrigation system	2
11	Design of mini sprinkler irrigation system	2
12	Design of micro sprinkler irrigation system	2
13	Installation of sprinkler irrigation system	2
14	Installation of drip irrigation system	2
15	Installation of mini sprinkler irrigation system	2
16	Installation of micro sprinkler irrigation system	2
17	Exercise on computation crop water requirement of crops using different approaches	2
18	Exercise on computation crop water requirement of crops using computer software	2
19	Studies on different soluble and liquid fertilizers, its solubility, compatibilities and different nutrient components	1
20	Acquaint with different fertigation equipment	1
21	Studies on adaptability and limitation of different fertigation systems	2
22	Installing of fertigation equipment	2
23	Execution of fertigation with water soluble fertilizers	2
24	Execution of fertigation with water liquid fertilizers	2
25	Maintenance of with different fertigation equipment	2
26	Execution of chemigation for different purposes	2
27	Operation and different MIS	4
28	Maintenance of MIS-Cleaning of different filters	2
29	Maintenance of MIS-flushing of Mainline and submain lines	2
30	Maintenance of MIS-Laterals	2
31	Planning of maintenance schedule for different MIS under different water qualities	1
32	Studies on different criteria for automated MIS	1
33	Acquaint with different components of IoT for automated MIS	2
34	Uninstallation and storage of sprinkler irrigation system	2
35	Uninstallation and storage of drip irrigation system	2
36	Uninstallation and storage of mini sprinkler irrigation system	2
37	Uninstallation and storage of micro sprinkler irrigation system	2

SEMESTER-2 (SKILL ENHANCEMENT COURSE)

Sr. No.	Course Name	Course No.	Credit	L	P	T
14	Application of Remote Sensing and GIS for Agricultural Water Management	SEC14	4(0+4)	0	4	4

Practical Topics:

- Basics of remote sensing
- Remote sensing sensors and platforms
- Introduction to GIS
- Types of projection systems
- Study of Image resolutions and coordinate system
- Source of remote sensing data and accessibility
- Operations in Google earth platform
- Introduction to basic modules of ArcGIS
- Introduction to basic modules of QGIS
- Georeferencing, rectification, digitization and shape file creation
- Basic raster/vector data operations
- Map projection and re-projection
- Preparation of contour maps and rainfall Thiessen polygons
- Map layout and styling
- Preparation of various vegetation index maps
- Preparation of various wetness index maps
- Delineation of watershed and derivation of morphological parameters

Planning of lectures

S.No.	Topic	No. of Practicals
1	Basics of remote sensing	2
2	Remote sensing sensors and platforms	4
3	Introduction to GIS	4
4	Types of projection systems	4
5	Study of Image resolutions and coordinate system	4
6	Source of remote sensing data and accessibility	4
7	Operations in Google earth platform	4
8	Introduction to basic modules of ArcGIS	4
9	Introduction to basic modules of QGIS	4
10	Georeferencing, rectification, digitization and shape file creation	4
11	Basic raster/vector data operations	4
12	Map projection and re-projection	4
13	Preparation of contour maps and rainfall Thiessen polygons	4
14	Map layout and styling	4
15	Preparation of various vegetation index maps	4
16	Preparation of various wetness index maps	4

17	Delineation of watershed and derivation of morphological parameters	2
	Total	64

SEMESTER – 2 (SKILL ENHANCEMENT COURSE)

Sr. No.	Course Name	Course No.	Credit	L	P	T
15	Operation and Maintenance of Hydro-meteorological Instruments	SEC15	4(0+4)	0	4	4

Operation and Maintenance of Hydro-meteorological Instruments

- Study and operation of Weather monitoring Instruments: Thermometer, Barometer, Hygrometer; Anemometer, Pyranometer and others
- Components of an automatic weather station (AWS)
- Installation of AWS and its maintenance
- Calibration and installation of Tipping bucket raingauge
- Installation of open pan evaporimeter and periodic maintenance
- Study of infiltration process using ring infiltrometer
- Measurement of flow in open channels using various methods
- Study of different weirs and flumes for flow measurement
- Installation of weirs and flumes in the channel
- Measurement of soil moisture using gravimetric method
- In-situ measurement of soil moisture using different soil moisture sensors
- Installation of digital water level recorder (DWLR)
- Measurement of groundwater level using ground water level recorder
- Study of multi-slot divisor and Coshocton wheel silt sampler for measurement of soil loss
- Measurement of flow velocity using digital current meter
- Procedure for recording field observations
- Troubleshooting of hydro-meteorological instruments

Planning of Practicals		
Sr. No	Topics to be covered in Practical	No. of Practical
1.	Study and operation of Weather monitoring Instruments: Thermometer, Barometer, Hygrometer; Anemometer, Pyranometer and others	2
Components of an automatic weather station (AWS)		
2.	Study on Weather sensors i.e. Temperature sensor, Humidity sensor, Barometric pressure sensor, Wind speed sensor and Wind direction sensor	4
3.	Study on data collectors	2
4.	Study on various softwares for analyzing, visualizing, and reporting data	4
Installation of AWS and its maintenance		
5.	Study on installation of data transmission equipment, meteorological observation equipment, and power supply facilities.	2
6.	Study on equipment working and data transmission	2
7.	Study on network connection between the weather station and the data processing center	3
Calibration and installation of Tipping bucket raingauge		

8.	Study on calibration of tipping bucket raingauge	2
9.	Study on installation of tipping bucket raingauge	2
10.	Study on maintenance of tipping bucket raingauge	2
11.	Study on Installation of open pan evaporimeter and its periodic maintenance	3
Study of infiltration process using ring infiltrometer		
12.	Study on infiltration process using single ring infiltrometer	2
13.	Study on infiltration process using double ring infiltrometer	2
Measurement of water flow by various methods		
14.	Study on water flow measurement using velocity area method.	2
15.	Study on water flow measurement using weirs	2
16.	Study on water flow measurement using orifice	2
17.	Study on water flow measurement using Parshall flume	2
18.	Study on water flow measurement using H-flume	2
19.	Study on water flow measurement using coordinate method	2
20.	Measurement of soil moisture using gravimetric method	2
In-situ measurement of soil moisture using different soil moisture sensors		
21.	Study on soil moisture by time domain reflectometry method	2
22.	Study on soil moisture by Coaxial Impedance Dielectric Reflectometry method	2
23.	Study on soil moisture by Frequency Domain Reflectometry (FDR) method	2
24.	Study on installation of digital water level recorder (DWLR)	2
25.	Measurement of groundwater level using ground water level recorder	2
Study on soil loss measurement by various methods		
26.	Study on soil loss measurement by multi slot divisor technique	2
27.	Study on soil loss measurement by Coshocton wheel sampler	2
28.	Study on measurement of flow velocity using digital current meter	2
29.	Study on troubleshooting of hydro-meteorological instruments	2
Total		64

SEMESTER – 2 (SKILL ENHANCEMENT COURSE)

Sr. No.	Course Name	Course No.	Credit	L	P	T
16	Geophysical Survey and Investigations for Groundwater Exploration and Installation of Tube Well/ Bore Well	SEC16	4(0+4)	0	4	4

- Learn about different features of groundwater system
- Study of different types of geophysical survey
- Components of a resistivity meter
- Wenner-Schlumberger arrangement and comparison
- Process of geophysical survey in field
- Surveyed data analysis and interpretation
- Different types of well log and preparation of commonly used well log
- Study of different types of wells
- Study the components of a tube well/ bore well
- Study of different types of drilling methods/ equipments

- Installation of well assembly: types of casing, screen
- Study on gravel packing
- Study of well development process
- Sanitary protection of tube wells

Planning of Practicals		
Sr. No	Topics to be covered in Practical	No. of Practical
Learn about different features of groundwater system		
1.	Study on different aquifers	1
2.	Study on Groundwater recharge techniques	1
3.	Study on groundwater investigation techniques	1
4.	Study on groundwater quality	1
Study of different types of geophysical survey		
5.	Study on traditional methods for ground water investigation.	1
6.	Study on seismic reflection method for ground water investigation	1
7.	Study on ground penetrating radar (GPR)survey for ground water investigation	1
8.	Study on resistivity survey for ground water investigation	1
Components of a resistivity meter		
9.	Study on electrodes used in resistivity meter for ground water investigation	1
10.	Study on cables to connect the electrodes used in resistivity meter for ground water investigation	1
11.	Study on resistivity meter and power sources used in ground water investigation	1
Wenner-Schlumberger arrangement and comparison		
12.	Study on Wenner arrangement for geophysical surveys to measure electrical resistivity.	1
13.	Study on Schlumberger arrangement for geophysical surveys to measure electrical resistivity.	1
14.	Study on comparison on Wenner-Schlumberger arrangement for geophysical surveys to measure electrical resistivity.	1
Process of geophysical survey in field & Surveyed data analysis and interpretation		
15.	Study on method of geophysical survey i.e. collection of data	2
16.	Study on processing of collected data during geophysical survey	2
17.	Study on analyzing the processed data for geophysical survey	2
18.	Study on presenting the analyzed data in the form of maps, graphs and other graphical form	2
Different types of well log and preparation of commonly used well log		
19.	Study on electrical resistivity logs for groundwater investigation	2
20.	Study on acoustic well logs for groundwater investigation	1
21.	Study on gamma ray logs for groundwater investigation	2
22.	Study on induction well logs for groundwater investigation	1
23.	Study on spontaneous potential (SP) logs for groundwater investigation	1
24.	Study on neutron logs for groundwater investigation	1

25.	Study on Density logs for groundwater investigation	1
Study of different types of wells		
26.	Study on open well	1
27.	Study on tube well	1
28.	Study on dug-cum-bore well	1
29.	Study on skimming well	1
30.	Study on recharge well	1
Study the components of a tube well/ bore well		
31.	Study on open well lining	2
32.	Study on housing pipe in tube well	1
33.	Study on casing pipe in tube well	1
34.	Study on well screen used in tube well	1
35.	Study on artificial gravel packing in tube well	2
Study of different types of drilling methods/ equipment		
36.	Study on percussive drilling method for tube well construction	1
37.	Study on rotary drilling method for tube well construction	2
38.	Study on reverse circulation drilling method for tube well construction	2
39.	Study on down the hole (DTH) hydraulic rotary drilling method for tube well construction	2
40.	Study on jet drilling method for tube well construction	2
41.	Study on different drilling rigs used in tube well construction	1
Installation of well assembly: types of casing, screen		
42.	Study on installation of housing pipe, casing pipe and well screen in tube well.	1
Study on gravel packing		
43.	Study on artificial gravel packing in tube well	1
Study of well development process		
44.	Study on jetting method used in well development	1
45.	Study on surging method used in well development	2
46.	Study on air surging and pumping method used in well development	2
47.	Study on over pumping method used in well development	2
Sanitary protection of tube well		
48.	Study on disinfection, screening and gravel packing for sanitary protection of tube well.	2
Total practicals :		64

SEMESTER – 2 (SKILL ENHANCEMENT COURSE)

Sr. No.	Course Name	Course No.	Credit	L	P	T
17	Installation and Maintenance of Rooftop Rainwater Harvesting Systems	SEC17	4(0+4)	0	4	4

- Survey and site selection for RRWH
- Computation of rooftop RWH potential and runoff coefficient
- Study of components of RWH System
- Catchments: grading and plastering of rooftop
- Coarse mesh, gutters; roofing materials

- Conduit: material, size of conveyance pipe
- Types of filter system used in RWH system
- Study of storage tank: capacity, overflow pipe
- Study of suitable recharge structure for ground water
- Study of constructional details of recharge pits, recharge trench
- Types of contaminants in RWH system
- Hand pumps and its application in RWH system
- Preparation of Detail Project Report

Planning of Practicals		
Sr. No	Topics to be covered in Practical	No. of Practical
Survey and site selection for RRWH		
1.	Study on site selection of RRWH	1
Computation of rooftop RWH potential and runoff coefficient		
2.	Study on roof type, roof slope, roof catchment for RRWH	2
3.	Study on runoff distribution for RRWH	2
4.	Study on climatic parameters for designing RRWH	2
Study of components of RWH System		
5.	Study on water collection system for RRWH i.e. roof and gutters to collect rainwater	2
6.	Study on inlet filter for removing the large debris form rainwater	2
7.	Study on storage tank, filtration system and treatment system for RRWH	2
8.	Study on pump, backflow prevention flow meter, power supply and water level indicator used in RRWH.	2
Catchments: grading and plastering of rooftop		
9.	Study on various catchments, its grading and plastering of rooftop RWH	2
Coarse mesh, gutters; roofing materials		
10.	Study on selection of mesh size for removal of debris from rainwater	2
Conduit: material, size of conveyance pipe		
11.	Study on selection of conduit material for RRWH	2
12.	Study on selection of size of conveyance pipe for RRWH	2
Types of filter system used in RWH system		
13.	Study on sediment filter used in RRWH	2
14.	Study on carbon filter used in RRWH	2
15.	Study on reverse osmosis method used in RRWH	2
16.	Study on distillation method used in RRWH	2
Study of storage tank: capacity, overflow pipe		
17.	Study on designing the storage tank capacity of RRWH	2
18.	Study on designing the size and elevation of overflow pipe used in RRWH	2
Study of suitable recharge structure for ground water in RRWH		
19.	Study on Gravity head recharge well for ground water	2
20.	Study on infiltration basins for ground water recharge	2
21.	Study on recharge pits for ground water recharge	2
22.	Study on percolation tank for ground water recharge	2
Study of constructional details of recharge pits, recharge trench		

23.	Study of constructional details of recharge pits	2
24.	Study of constructional details of recharge trench	2
Types of contaminants in RWH system		
25.	Study on various size of particles in RWH	2
26.	Study of toxic metals in RWH	2
27.	Study on synthetic organic chemicals in RWH	2
28.	Study on waterborne pathogens in RWH	2
29.	Study on emerging contaminants in RWH	2
30.	Study on radiological contaminants in RWH	2
Hand pumps and its application in RWH system		
31.	Study on hand pump and its application in RWH system	2
Preparation of Detail Project Report		
32.	Preparation of Detail Project Report	3
Total practical :		64

SEMESTER – 2 (SKILL ENHANCEMENT COURSE)

Sr. No.	Course Name	Course No.	Credit	L	P	T
18	Operation and Maintenance of Soil Conservation Structures	SEC18	4(0+4)	0	4	4

Operation and Maintenance of Soil Conservation Structures

- Survey for slope, stream order and land use/land cover
- Site selection of soil conservation structures based on survey
- Ground truthing of various structures
- Study of different types of soil conservation structures
- Trenching and diversions structures
- Study of types bunding and its features
- Study of types of terracing and its features
- Study of drop spill way: components, function, site suitability
- Study of drop inlet spillway: components, function, site suitability
- Study of chute spillway: components, function, site suitability
- Study of check dams- construction, site suitability
- Study of construction materials of different structures
- Cost estimation of different conservation structures
- Preparation of Detail Project Report

Planning of Practicals		
Sr. No	Topics to be covered in Practical	No. of Practical
Survey for slope, stream order and land use/land cover		
1.	Field investigations, Site survey, preparation of topographic map/contour map for soil conservation structure planning	1
2.	Study on assessment of vegetation and ground cover by Remote Sensing data	1
3.	Preparation of digital topographic maps of watershed	1

4.	Study on Erosion risk assessment in the watershed	1
5.	Study on identification of problematic area in the watershed	1
Site selection of soil conservation structures based on survey		
6.	Study physical parameters of the watershed	1
7.	Analyze rainfall-runoff depth during monsoon season	1
8.	To perform site suitability analysis using weighted overlay techniques	1
9.	To locate suitable sites for different structures for conservation of soil and water.	1
Ground truthing of various structures		
10.	Study on ground truthing parameters for physibility of soil conservation structures	1
Study of different types of soil conservation structures		
11.	Study on bench terrace system	1
12.	Study on vegetative waterwys	1
13.	Study on nala bunding system	1
14.	Study on earthen dam	1
15.	Study on temperory gully control strucutres	1
16.	Study on drop spillway	1
17.	Study on drop inlet spillway	1
18.	Study on chute spillway	1
Trenching and diversions structures		
19.	Study on Continuous Trench and its design procedure	1
20.	Study on In-line Trench and its design procedure	1
21.	Study on Staggered Trench and its design procedure	1
22.	Study on contour trenching and its design procedure	1
23.	Study on Diversion channels, ditches and grassed waterways and its design procedure	1
Study of types bunding and its features		
24.	Study on contour bunding system and its design procedure	2
25.	Study on graded bunding system and its design procedure	2
Study of types of terracing and its features		
26.	Study on level bench terrace system and its design procedure	2
27.	Study on inward slopy bench terrace system and its design procedure	2
28.	Study on outward slopy bench terrace system and its design procedure	2
Study of drop spill way: components, function, site suitability		
29.	Study of drop spill way: components, function, site suitability	1
30.	Study on hydrologic design of drop spillway	2
31.	Study on hydraulic design of drop spillway	2
32.	Study on structural design of drop spillway	2
33.	Study on box inlet type drop spillway and its design procedure	2
Study of drop inlet spillway: components, function, site suitability		
34.	Study of drop inlet spillway: components, function, site suitability	2
35.	Study of design of pipe spillway in drop inlet structure	2
36.	Study of design of earthen dam in drop inlet structure	2
37.	Study on design of outlet components of drop inlet structure	2
Study of chute spillway: components, function, site suitability		
38.	Study of chute spillway: components, function, site suitability	1

39.	Study on design of inlet portion of chute structure	2
40.	Study on design of conduit portion of chute structure	2
41.	Study on design of SAF stilling basin of chute structure	2
Study of check dams- construction, site suitability		
42.	Study of check dams- construction, site suitability	1
Study of construction materials of different structures		
43.	Study of construction materials of different structures	2
Cost estimation of different conservation structures		
44.	Cost estimation of different conservation structures	2
Preparation of Detail Project Report		
45.	Preparation of Detail Project Report	2
Total practical :		64

SEMESTER-2 (SKILL ENHANCEMENT COURSE)

Sr. No.	Course Name	Course No.	Credit	L	P	T
19	Construction, management and maintenance of protected cultivation structures	SEC19	4(0+4)	0	4	4

- Study of different protected structures and their uses
- Acquaint with different components of protected structures
- Construction of different protected structures
- Study of glazing materials and their properties
- Selection of different construction materials and their specifications
- Management of micro climate parameters in protected structures
- Monitoring of micro climate inside protected structures
- Automatic monitoring of micro climate inside protected structure
- Use of Irrigation and fertigation in protected cultivation
- Visit to different hydroponics systems under protected structures.

Planning of lectures		
Sr. No.	Topics to be covered in Lecture	Proposed No. of Lectures
1.	Study of different protected structures and their uses	6
2.	Acquaint with different components of protected structures	6
3.	Construction of different protected structures	6
4.	Study of glazing materials and their properties	6
5.	Selection of different construction materials and their specifications	6
6.	Management of micro climate parameters in protected structures	6
7.	Monitoring of micro climate inside protected structures	6
8.	Automatic monitoring of micro climate inside protected structure	6
9.	Use of Irrigation and fertigation in protected cultivation	6
10.	Visit to different hydroponics systems under protected structures	6
Total		60

SEMESTER-2 (SKILL ENHANCEMENT COURSE)

Sr. No.	Course Name	Course No.	Credit	L	P	T
20	Agro Processing Methods, Equipment Operation, and Maintenance	SEC20	4(0+4)	0	4	4

Practical:

Introduction to Agro Processing : Introduction to Agro Processing & Importance; Food Safety & Hygiene in Agro Processing; Basic Tools & Safety Measures in Agro Processing; Cleaning & Sanitation of Equipment; Handling and Storage of Raw Materials; Waste Management in Agro Processing; Energy Efficiency in Agro Processing Units; Water Usage & Recycling in Processing; Environmental Considerations in Agro Processing; Quality Control & Product Standardization;

Cereal & Pulse Processing : Rice Milling (Process, Equipment, and Maintenance); Wheat Milling and Flour Processing; Corn Milling and Starch Extraction; Pulse Processing (Cleaning, Dehulling, and Splitting); Oilseed Processing & Extraction Methods; Storage and Packaging of Grains; Grinding & Sieving Techniques; Fortification Techniques in Cereal Processing; By-products Utilization in Grain Processing; Maintenance of Milling Machines

Fruits & Vegetables Processing : Pre-treatment of Fruits & Vegetables (Sorting, Grading, Washing); Juice Extraction and Preservation; Jam, Jelly, and Pickle Processing; Dehydration of Fruits & Vegetables; Freezing and Cold Storage Techniques; Fermentation & Vinegar Production; Tomato Processing (Sauce, Puree, Paste); Canning and Bottling Techniques; Maintenance of Fruit & Vegetable Processing Equipment; Waste Utilization in Fruit & Vegetable Processing

Dairy & Meat Processing : Milk Collection & Quality Testing; Pasteurization & Homogenization of Milk; Cheese & Butter Making Process; Ice Cream & Yogurt Production; Cleaning & Sanitization of Dairy Equipment; Meat Processing – Cutting, Curing & Preservation; Poultry Processing – Slaughtering & Dressing; Cold Chain Management in Dairy & Meat Processing; By-products Utilization in Dairy & Meat Industry; Maintenance of Dairy & Meat Processing Equipment

Oil & Sugar Processing : Oil Extraction Techniques (Cold & Hot Pressing); Refining of Edible Oils; Sugarcane Processing – Juice Extraction & Clarification; Jaggery & Khandsari Manufacturing; Honey Processing & Packaging; Palm & Coconut Oil Processing; Molasses & Alcohol Production from Sugarcane; Bakery Product Processing (Bread, Biscuits, Cakes); Safety Measures in Sugar & Oil Processing Units; Maintenance of Sugarcane & Oilseed Processing Equipment

Equipment Operation & Maintenance : Operation & Maintenance of Hammer Mills; Operation & Maintenance of Pulverizers; Operation & Maintenance of Steam Boilers; Operation & Maintenance of Dehydrators; Operation & Maintenance of Extruders; Operation & Maintenance of Cold Storage Units; Operation & Maintenance of Pasteurizers; Operation & Maintenance of Fermenters; Operation & Maintenance of Packaging Machines; Calibration & Maintenance of Weighing Equipment; Safety Protocols for Agro Processing Machinery; Lubrication & Preventive Maintenance Practices; Breakdown Analysis & Troubleshooting; Final Assessment & Hands-on Workshop.

Planning of lectures		
Sr.	Topics to be covered in Lecture	Proposed

No.		No. of Lectures
Module 1-10: Introduction to Agro Processing		
1.	Study on introduction & importance of agro processing	1
2.	Study of food safety & hygiene in agro processing	1
3.	To study basic tools & safety measures in agro processing	1
4.	To study cleaning & sanitation of equipment	1
5.	To study handling and storage of raw materials	1
6.	To study waste management in agro processing	1
7.	To study energy efficiency in agro processing units	1
8.	To study water usage & recycling in processing	1
9.	To study environmental considerations in agro processing	1
10.	To study quality control & product standardization	1
Module 11-20: Cereal & Pulse Processing		
11.	To study rice milling (process, equipment, and maintenance)	1
12.	To study wheat milling and flour processing	1
13.	To study corn milling and starch extraction	1
14.	To study pulse processing (cleaning, dehulling, and splitting)	1
15.	To study oilseed processing & extraction methods	1
16.	To study storage and packaging of grains	1
17.	To study grinding & sieving techniques	1
18.	To study fortification techniques in cereal processing	1
19.	To study by-products utilization in grain processing	1
20.	To study maintenance of milling machines	1
Module 21-30: Fruits & Vegetables Processing		
21.	To study pre-treatment of fruits & vegetables (sorting, grading, washing)	1
22.	To study juice extraction and preservation	1
23.	To study jam, jelly, and pickle processing	1
24.	To study dehydration of fruits & vegetables	1
25.	To study freezing and cold storage techniques	1
26.	To study fermentation & vinegar production	1
27.	To study tomato processing (sauce, puree, paste)	1
28.	To study canning and bottling techniques	1
29.	To study maintenance of fruit & vegetable processing equipment	1
30.	To study waste utilization in fruit & vegetable processing	1
Module 31-40: Dairy & Meat Processing		
31.	To study milk collection & quality testing	1
32.	To study pasteurization & homogenization of milk	1
33.	To study cheese & butter making process	1
34.	To study ice cream & yogurt production	1
35.	To study cleaning & sanitization of dairy equipment	1
36.	To study meat processing – cutting, curing & preservation	1
37.	To study poultry processing – slaughtering & dressing	1
38.	To study cold chain management in dairy & meat processing	1
39.	To study by-products utilization in dairy & meat industry	1
40.	To study maintenance of dairy & meat processing equipment	1
Module 41-50: Oil & Sugar Processing		

41.	To study oil extraction techniques (cold & hot pressing)	1
42.	To study refining of edible oils	1
43.	To study sugarcane processing – juice extraction & clarification	1
44.	To study jaggery & khandsari manufacturing	1
45.	To study honey processing & packaging	1
46.	To study palm & coconut oil processing	1
47.	To study molasses & alcohol production from sugarcane	1
48.	To study bakery product processing (bread, biscuits, cakes)	1
49.	To study safety measures in sugar & oil processing units	1
50.	To study maintenance of sugarcane & oilseed processing equipment	1
Module 51-64: Equipment Operation & Maintenance		
51.	To study operation & maintenance of hammer mills	1
52.	To study operation & maintenance of pulverizers	1
53.	To study operation & maintenance of steam boilers	1
54.	To study operation & maintenance of dehydrators	1
55.	To study operation & maintenance of extruders	1
56.	To study operation & maintenance of cold storage units	1
57.	To study operation & maintenance of pasteurizers	1
58.	To study operation & maintenance of fermenters	1
59.	To study operation & maintenance of packaging machines	1
60.	To study calibration & maintenance of weighing equipment	1
61.	To study safety protocols for agro processing machinery	1
62.	To study lubrication & preventive maintenance practices	1
63.	To study breakdown analysis & troubleshooting	1
64.	Final assessment & hands-on workshop	1
Total		64

SEMESTER – 2

Sr. No.	Course Name	Course No.	Credit	L	P	T
21	Operation and management of multi-commodity agro-processing centre	SEC 21	4 (0+4)	0	4	4

Practical topics:

1. Acquaintance with different agro-processing models.
2. Site selection, plant layout and project report preparation.
3. Manufacturing and management of primary processing centre.
4. Preparation of grain, pulse and oilseed- based products and acquaintance with operation of different equipment.
5. Preparation of products using flour mill.
6. Spice processing and acquaintance with operation of different equipment.
7. Operation and management of fruit and vegetable pack house.
8. Preparation of different fruit- based products and acquaintance with operation of different equipment.
9. Manufacturing of snack foods.
10. Acquaintance with food safety and hygiene, and certifications.

11. Record keeping, inventory, finance and human resource management for agro-processing.

Planning of Practical		
Sr. No.	Topics	Proposed No. of Practical
1	To study the overview of agro-processing models and its role, utility, application in food processing sector.	2
2	Evaluation of agro-processing models through various successful case studies on rural development and entrepreneurship in young generation.	3
3	To study the comparative analysis of centralized and decentralized agro-processing systems in India.	2
4	To study on the operational features of small-scale, medium scale and large-scale agro-processing units of various agricultural commodities.	2
5	To study on the various factors influencing site selection, steps in designing efficient plant layouts, environmental and economic considerations and plant location for agro-processing plants.	3
6	To study on manufacturing, operations and management, resource planning, allocation and quality control systems and project preparations in primary processing centers.	3
7	To study on automation, regulatory compliance and risk management and efficiency improvements in primary processing plants.	2
8	To study on the various processing technologies such as milling and grinding techniques, hand on operation, performance evaluation grain-based food products for pulse and oilseed processing	3
9	To study on value addition and product development and process standardization from grains, pulses, and oilseeds.	3
10	To study on flour milling machinery: maintenance and troubleshooting, operational procedures for whole wheat flour production, role of sieving and sifting in flour milling.	3
11	To study the technical aspects of wheat grinding and flour quality control and exploring by-products of flour milling for value addition	3
12	To study on various unit operation and techniques like drying, grinding, spice blending and packaging and spice preservation and its practical applications.	3
13	To study on quality assurance in spice processing: testing and standards.	2
14	To study the various operations of machineries, management of manpower and reporting of fruit and vegetable pack house.	1
15	Preparation of different fruit- based products and acquaintance with operation of different equipment such as fruits and the production of purées for use in beverages, desserts, or as ingredients in other fruit-based products.	4
16	To study the techniques of canning fruits, including the pasteurization and sterilization process and the use of pressure cooking or autoclaving for long-term storage.	2
17	To study on manufacturing of snack foods includes the various operations like extrusion-based snack production, potato chips manufacturing and frying techniques, corn-based snack production.	3

18	To study on traditional Indian snack preparation: <i>namkeen</i> and <i>bhujia</i> , multigrain snack chips production, manufacturing of sweet snack products: candy bars and biscuits, cereal-based snack foods.	4
19	To study on the food safety and hygiene regulations, sanitation practices in food processing units, principles of Hazard Analysis And Critical Control Points (HACCP).	3
20	To study on the food safety audits and inspection procedures, personal hygiene and its role in food safety, Good Manufacturing Practices (GMP) in food production, understanding ISO 22000 food safety management system, allergen management and labeling in food products.	3
21	To study on the organic food certifications and standards. Certification process for food safety and quality assurance, food packaging and its role in ensuring safety and hygiene	2
22	To study on the introduction part to record keeping in agro-processing units, inventory management systems in agro-processing, financial planning and budgeting for agro-processing enterprises.	2
23	To study the cash flow management and profitability analysis in agro-processing, costing and pricing strategies for agro-processed products, human resource management in agro-processing in cost analysis.	3
24	To study on workforce optimization in agro-processing, digital tools for inventory and financial management in agro-processing, employee performance appraisal and incentive systems in agro-processing, setting up and managing an agro-processing enterprise's financial records of employs.	3
Total		64

SEMESTER – 2

Sr. No.	Course Name	Course No.	Credit	L	P	T
22	Primary Processing, Value Addition and Cold Chain Logistics	SEC 22	4 (0+4)	0	4	4

Practical:

Introduction to Primary Processing & Value Addition : Basics of Primary Processing & Value Addition; Importance of Post-Harvest Management; Quality Assessment of Raw Agricultural Produce; Cleaning, Sorting, and Grading Techniques; Drying and Dehydration Methods; Storage Techniques for Perishable & Non-Perishable Goods; Primary Packaging of Agricultural Produce; Waste Management & By-Product Utilization; Safety Measures in Primary Processing; Hands-on Practice: Sorting and Grading of Fruits & Vegetables

Processing of Cereals, Pulses & Oilseeds : Rice Milling & Processing Techniques; Wheat Milling & Flour Processing; Corn Milling & Starch Extraction; Pulse Processing: Dehulling & Splitting; Oil Extraction Methods: Cold Press & Expeller; Fortification of Cereals & Pulses; Value Addition in Rice: Rice Bran Oil, Puffed Rice; Production of Edible Oils from Oilseeds; By-product Utilization in Cereal & Pulse Processing; Hands-on Training: Operating a Flour Mill & Oil Expeller

Fruits & Vegetable Processing & Value Addition : Pre-treatment of Fruits & Vegetables (Washing, Peeling, Cutting); Juice Extraction & Preservation Techniques; Jam, Jelly, and Pickle Production; Fruit & Vegetable Dehydration; Freezing & Cold Storage of Perishable Produce; Tomato Processing: Sauce, Puree, Paste; Fermentation for Value Addition: Vinegar & Sauerkraut; Canning & Bottling of Fruits & Vegetables; Hands-on Training: Juice Extraction & Jam Making; Hands-on Training: Drying & Freezing of Vegetables

Dairy & Meat Processing & Value Addition : Milk Collection, Quality Testing & Standardization; Pasteurization & Homogenization of Milk; Cheese, Butter & Ghee Processing; Ice Cream & Yogurt Production; Cleaning & Sanitization of Dairy Processing Equipment; Meat Processing: Cutting, Curing, and Preservation; Poultry Processing: Slaughtering, Dressing & Packaging; Value Addition in Dairy: Flavored Milk, Whey Utilization; Hands-on Training: Cheese & Butter Making; Hands-on Training: Meat Processing & Packaging

Cold Chain Logistics & Supply Chain Management :Basics of Cold Chain Logistics & Importance; Different Types of Cold Storage Systems; Pre-cooling & Refrigeration Techniques; Packaging & Handling of Perishable Products; Temperature Monitoring & Control in Cold Chain; Cold Chain Transport & Last-Mile Delivery; Warehousing & Inventory Management for Perishables; Food Safety & Hygiene in Cold Chain Logistics; Case Studies on Effective Cold Chain Management; Hands-on Training: Operating Cold Storage & Refrigeration Units

Equipment Operation, Maintenance & Quality Control : Operation & Maintenance of Cleaning & Sorting Machines; Operation & Maintenance of Milling & Grinding Equipment; Operation & Maintenance of Dryers & Dehydrators; Operation & Maintenance of Oil Extractors & Presses; Operation & Maintenance of Dairy Processing Equipment; Operation & Maintenance of Refrigeration & Cold Storage Units; Operation & Maintenance of Pasteurizers & Fermenters; Operation & Maintenance of Freezers & Ice-Making Units; Packaging & Labeling Techniques for Value-Added Products; Quality Control & Testing of Processed Products; Food Safety Standards & Regulatory Compliance; Lubrication & Preventive Maintenance of Agro-Processing Equipment; Hands-on Training: Breakdown Analysis & Troubleshooting; Final Project & Practical Assessment

Planning of lectures		
Sr. No.	Topics to be covered in Lecture	Proposed No. of Lectures
Module 1-10: Introduction to Primary Processing & Value Addition		
1.	To study basics of primary processing & value addition	1
2.	To study importance of post-harvest management	1
3.	To study quality assessment of raw agricultural produce	1
4.	To study cleaning, sorting, and grading techniques	1
5.	To study drying and dehydration methods	1
6.	To study storage techniques for perishable & non-perishable goods	1
7.	To study primary packaging of agricultural produce	1
8.	To study waste management & by-product utilization	1
9.	To study safety measures in primary processing	1
10.	To study hands-on practice: sorting and grading of fruits & vegetables	1

Module 11-20: Processing of Cereals, Pulses & Oilseeds		
11.	To study rice milling & processing techniques	1
12.	To study wheat milling & flour processing	1
13.	To study corn milling & starch extraction	1
14.	To study pulse processing: dehulling & splitting	1
15.	To study oil extraction methods: cold press & expeller	1
16.	To study fortification of cereals & pulses	1
17.	To study value addition in rice: rice bran oil, puffed rice	1
18.	To study production of edible oils from oilseeds	1
19.	To study by-product utilization in cereal & pulse processing	1
20.	To study hands-on training: operating a flour mill & oil expeller	1
Module 21-30: Fruits & Vegetable Processing & Value Addition		
21.	To study pre-treatment of fruits & vegetables (washing, peeling, cutting)	1
22.	To study juice extraction & preservation techniques	1
23.	To study jam, jelly, and pickle production	1
24.	To study fruit & vegetable dehydration	1
25.	To study freezing & cold storage of perishable produce	1
26.	To study tomato processing: sauce, puree, paste	1
27.	To study fermentation for value addition: vinegar & sauerkraut	1
28.	To study canning & bottling of fruits & vegetables	1
29.	To study hands-on training: juice extraction & jam making	1
30.	To study hands-on training: drying & freezing of vegetables	1
Module 31-40: Dairy & Meat Processing & Value Addition		
31.	To study milk collection, quality testing & standardization	1
32.	To study pasteurization & homogenization of milk	1
33.	To study cheese, butter & ghee processing	1
34.	To study ice cream & yogurt production	1
35.	To study cleaning & sanitization of dairy processing equipment	1
36.	To study meat processing: cutting, curing, and preservation	1
37.	To study poultry processing: slaughtering, dressing & packaging	1
38.	To study value addition in dairy: flavored milk, whey utilization	1
39.	To study hands-on training: cheese & butter making	1
40.	To study hands-on training: meat processing & packaging	1
Module 41-50: Cold Chain Logistics & Supply Chain Management		
41.	To study basics of cold chain logistics & importance	1
42.	To study different types of cold storage systems	1
43.	To study pre-cooling & refrigeration techniques	1
44.	To study packaging & handling of perishable products	1
45.	To study temperature monitoring & control in cold chain	1
46.	To study cold chain transport & last-mile delivery	1
47.	To study warehousing & inventory management for perishables	1
48.	To study food safety & hygiene in cold chain logistics	1
49.	To study case studies on effective cold chain management	1
50.	To study hands-on training: operating cold storage & refrigeration units	1
Module 51-64: Equipment Operation, Maintenance & Quality Control		

51.	To study operation & maintenance of cleaning & sorting machines	1
52.	To study operation & maintenance of milling & grinding equipment	1
53.	To study operation & maintenance of dryers & dehydrators	1
54.	To study operation & maintenance of oil extractors & presses	1
55.	To study operation & maintenance of dairy processing equipment	1
56.	To study operation & maintenance of refrigeration & cold storage units	1
57.	To study operation & maintenance of pasteurizers & fermenters	1
58.	To study operation & maintenance of freezers & ice-making units	1
59.	To study packaging & labeling techniques for value-added products	1
60.	To study quality control & testing of processed products	1
61.	To study food safety standards & regulatory compliance	1
62.	To study lubrication & preventive maintenance of agro-processing equipment	1
63.	To study hands-on training: breakdown analysis & troubleshooting	1
64.	Final project & practical assessment	1
Total		64

SEMESTER – 2

Sr. No.	Course Name	Course No.	Credit	L	P	T
23	Food grain godown and warehouse management	SEC 23	4 (0+4)	0	4	4

Practical topics:

1. Conversant with technical terms of grain storage, measurement of temperature, relative humidity, grain sampling and moisture content measurement, grain quality/.
2. Acquaintance with different factors for grain deterioration during storage and main insects of stored commodities.
3. Acquaintance with warehouse equipment and different storage structures.
4. Cleaning, drying and aeration of stored products.
5. Determination of dimension of warehouse for bag storage.
6. Acquaintance with constructional features, maintenance, sanitation and hygiene of warehouses.
7. Study on integrated pest management, chemical and non-chemical pest and rodent control measures in grain storage system
8. Detection methods of insect infestation in food grains and prevention and control of storage fungi
9. Acquaintance with inventory, logistics, and collateral management.
10. Guideline for procurement and disposal of food grains.
11. Quality control of food grains

Planning of Practical		
Sr. No.	Topics	Proposed No. of Practical
1	To study the fundamentals of grain storage technical terms and measurement technologies of all the environmental parameters.	2
2	To study temperature and relative humidity measurement in grain storage.	2

3	To study the moisture migration in the grain storage structure during summer and winter season and its effective control measures.	2
4	To study grain sampling techniques in food grain godown and moisture content measurement and grain quality assessment.	4
5	To study the different factors for food grain deterioration during storage, study on spoilage mechanism and identification of common insects in different stored commodities.	4
6	To study the different equipment / instruments / machineries used in the warehouse during grain storage	3
7	To study the different traditional, improved and modern storage structure and its comparative analysis with the on farm storage and warehouse system.	3
8	To study the design of aeration systems for stored products in food grain godown and warehouse	2
9	Exercise on cleaning procedures for stored grains in food grain godown and warehouse	1
10	Performance evaluation of various traditional and modern drying techniques for stored products in food grain godown and warehouse	3
11	Design a bag storage structures for the calculation of warehouse dimensions for various stored grains.	3
12	To study on the design of various grain silo storage system	3
13	To study constructional features and maintenance practices of grain storage warehouses	2
14	To study on sanitation and hygiene practices in food grain godown warehouse management	2
15	To study Integrated Pest Management (IPM) in grain storage systems	2
16	To study chemical and non-chemical pest and rodent control in grain storage	2
17	To study detection methods for insect infestation in food grains godown and warehouse	2
18	To study analytical methods of prevention and control measures for storage fungi in practices in food grain godown warehouse	4
19	To study inventory management in grain storage and warehousing	2
20	To study to study logistics and collateral management in food grain storage operations	4
21	To study guidelines for procurement and disposal of food grains	2
22	Study on the impact of grain packaging materials on storage efficiency in the warehouse system	2
23	To study on controlled and modified atmospheric storage in grain warehousing.	2
24	To study the analysis of energy consumption in warehouse during various operations	1
25	To study on a model warehouse for multi-commodity storage	2
26	To study on risk assessment and fire safety measures in grain warehousing.	1
27	Visit of various food grain godown and warehouse of agricultural commodities and prepare the report on the visit.	2
Total		64

SEMESTER – 2

Sr. No.	Course Name	Course No.	Credit	L	P	T
24	Post-Harvest Value Chain Management Including Logistics	SEC 24	4 (0+4)	0	4	4

Practical topics:

Introduction to Post-Harvest Value Chain Management : Basics of Post-Harvest Value Chain & Importance; Post-Harvest Losses: Causes & Prevention; Quality Assessment of Agricultural Produce; Cleaning, Sorting, and Grading Techniques; Primary Packaging & Handling of Fresh Produce; Post-Harvest Processing for Extended Shelf Life; Storage Techniques: Dry vs. Cold Storage; Supply Chain Flow from Farm to Consumer; Waste Management & By-product Utilization; Hands-on Training: Sorting & Grading of Fruits & Vegetables

Packaging & Preservation Techniques : Traditional vs. Modern Packaging Methods; Modified Atmosphere Packaging (MAP); Vacuum Packaging & Controlled Atmosphere Storage; Packaging Materials & Their Role in Shelf Life Extension; Edible Coatings & Their Application in Fruits & Vegetables; Role of Cold Chain in Perishable Packaging; Aseptic Packaging for Dairy & Juice Products; Sustainable Packaging & Biodegradable Materials; Hands-on Training: Vacuum & MAP Packaging; Hands-on Training: Edible Coating Application

Storage & Warehouse Management : Storage Principles for Grains & Pulses; Cold Storage & Controlled Temperature Warehousing; Bulk vs. Packaged Storage: Advantages & Limitations; Pest & Rodent Control in Warehouses; Humidity & Temperature Control in Storage Facilities; Inventory Management & FIFO System in Warehousing; Smart Storage Technologies: IoT in Warehousing; Role of Silos & Godowns in Large-Scale Storage; Hands-on Training: Operating Cold Storage Units; Hands-on Training: Warehouse Inventory Management

Logistics & Transportation Management : Basics of Agri-Logistics & Distribution; Cold Chain Transport & Refrigerated Vehicles; Route Optimization & Cost-Efficient Transport Planning; Third-Party Logistics (3PL) & Its Role in Agri-Trade; Post-Harvest Handling & Loading/Unloading Practices; Packaging Considerations for Long-Distance Transport; Role of Blockchain in Supply Chain Transparency; Case Studies on Successful Agri-Logistics Models; Hands-on Training: Temperature Monitoring in Transit; Hands-on Training: Route Planning for Agri-Supply Chain

Value Addition & Processing for Market Readiness : Introduction to Agro-Processing & Value Addition; Processing of Grains for Fortification & Enhanced Nutrition; Juice & Pulp Extraction Techniques; Pickling, Jam, & Jelly Production for Value Addition; Drying & Dehydration of Fruits & Vegetables; Fermentation & Probiotic Product Development; Ready-to-Eat & Ready-to-Cook Product Development; Hands-on Training: Dehydration of Perishable Produce; Hands-on Training: Fermented Beverage Production; Hands-on Training: Jam & Jelly Processing

Quality Control, Marketing & Digital Innovations : Food Safety Standards & Regulations (FSSAI, HACCP, GMP), Quality Control & Testing of Processed Products; Certification & Labeling for Export & Domestic Markets; Traceability & Digital Supply Chain Management; E-

Commerce & Direct-to-Consumer Models in Agri-Trade; Role of Cooperatives & FPOs in Value Chain Enhancement; Smart Contracts & AI in Post-Harvest Management; Digital Platforms & Market Linkages for Farmers; Hands-on Training: Testing & Certification of Agro-Products; Hands-on Training: Setting Up an Online Market for Farm Produce; Final Practical: End-to-End Post-Harvest Supply Chain Simulation; Lubrication & Preventive Maintenance of Post-Harvest Equipment; Breakdown Analysis & Troubleshooting of Storage & Logistics Equipment; Final Project & Assessment

Planning of lectures		
Sr. No.	Topics to be covered in Lecture	Proposed No. of Lectures
Module 1-10: Introduction to Post-Harvest Value Chain Management		
1.	To study basics of post-harvest value chain & importance	1
2.	To study post-harvest losses: causes & prevention	1
3.	To study quality assessment of agricultural produce	1
4.	To study cleaning, sorting, and grading techniques	1
5.	To study primary packaging & handling of fresh produce	1
6.	To study post-harvest processing for extended shelf life	1
7.	To study storage techniques: dry vs. cold storage	1
8.	To study supply chain flow from farm to consumer	1
9.	To study waste management & by-product utilization	1
10.	To study hands-on training: sorting & grading of fruits & vegetables	1
Module 11-20: Packaging & Preservation Techniques		
11.	To study traditional vs. modern packaging methods	1
12.	To study modified atmosphere packaging (MAP)	1
13.	To study vacuum packaging & controlled atmosphere storage	1
14.	To study packaging materials & their role in shelf life extension	1
15.	To study edible coatings & their application in fruits & vegetables	1
16.	To study role of cold chain in perishable packaging	1
17.	To study aseptic packaging for dairy & juice products	1
18.	To study sustainable packaging & biodegradable materials	1
19.	To study hands-on training: vacuum & MAP packaging	1
20.	To study hands-on training: edible coating application	1
Module 21-30: Storage & Warehouse Management		
21.	To study storage principles for grains & pulses	1
22.	To study cold storage & controlled temperature warehousing	1
23.	To study bulk vs. packaged storage: advantages & limitations	1
24.	To study pest & rodent control in warehouses	1
25.	To study humidity & temperature control in storage facilities	1
26.	To study inventory management & FIFO system in warehousing	1
27.	To study smart storage technologies: IoT in warehousing	1
28.	To study role of silos & godowns in large-scale storage	1
29.	To study hands-on training: operating cold storage units	1
30.	To study hands-on training: warehouse inventory management	1
Module 31-40: Logistics & Transportation Management		
31.	To study basics of agri-logistics & distribution	1
32.	To study cold chain transport & refrigerated vehicles	1

33.	To study route optimization & cost-efficient transport planning	1
34.	To study third-party logistics (3PL) & its role in agri-trade	1
35.	To study post-harvest handling & loading/unloading practices	1
36.	To study ackaging considerations for long-distance transport	1
37.	To study role of blockchain in supply chain transparency	1
38.	To study case studies on successful agri-logistics models	1
39.	To study hands-on training: temperature monitoring in transit	1
40.	To study hands-on training: route planning for agri-supply chain	1
Module 41-50: Value Addition & Processing for Market Readiness		
41.	To study introduction to agro-processing & value addition	1
42.	To study processing of grains for fortification & enhanced nutrition	1
43.	To study juice & pulp extraction techniques	1
44.	To study pickling, jam, & jelly production for value addition	1
45.	To study drying & dehydration of fruits & vegetables	1
46.	To study fermentation & probiotic product development	1
47.	To study ready-to-eat & ready-to-cook product development	1
48.	To study hands-on training: dehydration of perishable produce	1
49.	To study hands-on training: fermented beverage production	1
50.	To study hands-on training: jam & jelly processing	1
Module 51-64: Quality Control, Marketing & Digital Innovations		
51.	To study food safety standards & regulations (FSSAI, HACCP, GMP)	1
52.	To study quality control & testing of processed products	1
53.	To study certification & labeling for export & domestic markets	1
54.	To study traceability & digital supply chain management	1
55.	To study e-commerce & direct-to-consumer models in agri-trade	1
56.	To study role of cooperatives & FPOs in value chain enhancement	1
57.	To study smart contracts & AI in post-harvest management	1
58.	To study digital platforms & market linkages for farmers	1
59.	To study hands-on training: testing & certification of agro-products	1
60.	To study hands-on training: setting up an online market for farm produce	1
61.	To study final practical: end-to-end post-harvest supply chain simulation	1
62.	To study lubrication & preventive maintenance of post-harvest equipment	1
63.	To study breakdown analysis & troubleshooting of storage & logistics equipment	1
64.	Final project & assessment	1
Total		64

FACULTY OF AGRICULTURAL ENGINEERING				
Undergraduate Course Curriculum				
Sr. No.	Course Number	Course Title	Credit Hours	Total Credit Hours
Second Year				
Semester - III				
1	AS3.1	Engineering Mathematics- I	3 (3+0)	

2	AS3.2	Engineering Physics	3 (2+1)	26 (17+9) +1* Non- Gradial
3	AS3.3	Engineering Chemistry	3 (2+1)	
4	FMPE3.4	Engineering Mechanics	3 (2+1)	
5	SWCE3.5	Watershed Hydrology	3 (2+1)	
6	IDE3.6	Fluid Mechanics and Open Channel Hydraulics	3 (2+1)	
7	PFE3.7	Engineering Properties of Agricultural Produce and Food Science	3 (2+1)	
8	FMPE3.8	Farm Machinery & Equipment - I	3 (2+1)	
9	AEC - III	Physical Education, First Aid and Yoga Practice	2 (0+2)	
10	AEC-IX or AEC-X	National Service Scheme (NSS-III) or National Cadet Corps(NCC-III)	1*(0+1)	

Semester – 3

Sr. No.	Course Name	Course No.	Credit	L	P	T
1	Engineering Mathematics-I	AS3.1	3(3+0)	3	0	3

Objective

To make the students acquainted with the basic mathematics applied in engineering and their applications in solving engineering problems

Theory

Differential Equations: first order differential equations, exact and reducible to exact form by integrating factors, linear differential equation and Bernoulli's equation, equations of first order and higher degree, Clairaut's equation;

Higher order differential equations: methods of finding complementary functions and particular integrals, methods of variation of parameters, Cauchy's and Legendre's linear equations, simultaneous linear differential equations with constant coefficients

Differential calculus: functions of two or more variables, Taylor's and Maclaurin's expansions,

Maxima and minima;

Partial differential equations: partial derivative and total derivative, homogeneous functions and Euler's theorem. Formation of PDE, higher order linear PDE with constant coefficients, solution of non-linear PDE, Charpit's method

Integral calculus: double integrals, change of order of integration, triple integrals, application of double and triple integrals to find area and volume

Matrices: elementary transformations, Gauss elimination, Gauss-Jordan method to find the inverse of a matrix. rank of a matrix, solution of linear equations, Eigen values and Eigen vectors, Cayley- Hamilton Theorem- it's use to find inverse of the matrix, linear transformation, diagonalization of matrices

Planning of Lectures		
Sr. No	Topics to be covered in lecture	Proposed No. of Lectures
1.	Exact and Bernoulli's Differential equations, Equations, Reducible to exact form by integrating factors, equations of first order and higher degree, Clairaut's equation.	6
2.	Differential equations of higher orders, Methods of finding Complementary functions and particular integrals, Method of variation of parameters.	5
3.	Cauchy's and Legendre's linear equation, Simultaneous linear differential equations with constant coefficients.	3
4.	Functions of two or more variables, Taylor's and Maclaurin's expansions, Maxima and minima.	6
5.	Partial derivatives and total derivatives, Homogeneous function and Euler's theorem.	4
6.	Higher order linear PDE With constant coefficients, Solution of non-linear PDE, Charpit's method	5
7.	double integrals, change of order of integration, triple integrals, application of double and triple integrals to find area and volume	5
8.	Elementary transformations, rank of a matrix, solution of linear equation.	5
9.	Gauss-Jordan method to find the inverse of a matrix.	2
10.	Eigen values and Eigen vectors, Cayley- Hamilton Theorem- it's use to find inverse of the matrix	4
11.	linear transformation, diagonalization of matrices	3
Total		48

Suggested Reading

1. Narayan S. 2004. *Differential Calculus*. S. Chand and Co. Ltd. New Delhi.
2. Narayan S. 2004. *Integral Calculus*. S. Chand and Co. Ltd. New Delhi.
3. Grewal B S. 2004. *Higher Engineering Mathematics*. Khanna Publishers Delhi.
4. Narayan S. 2004. *A Text Book of Vector*. S. Chand and Co. Ltd. New Delhi.

SEMESTER – 3

Sr. No.	Course Name	Course No.	Credit	L	P	T
2	Engineering Physics	AS3.2	3 (2+1)	2	1	3

Planning of lectures		
Sr. No.	Topics to be covered in lecture	Proposed No. of Lecture
1	Magnetism: Dia, para and ferro-magnetism- classification	3
2	Langrevin theory of dia, and para magnetism, adiabatic demagnetization	2
3	Weiss molecular field theory	2
4	Introduction to quantum mechanics: wave particles duality, deBroglie concept uncertainty principle,	2
5	Time dependent and time independent Schrodinger equation	3
6	Spectroscopy: Qualitative explanation of Zeeman effect, Stark effect and Paschen back effect Raman spectroscopy; Solid state physics: statement of Bloch function, bands in solids, effective mass,	2
7	distinction between metals, insulators and semi-conductors. Semiconductors: Intrinsic and extrinsic semi-conductors	2
8	law of mass action, determination of energy gap in semi-conductors, donors and acceptor levels	1
9	Superconductivity; critical magnetic field, Meissner effect, isotope effect, Type I and II superconductors,	2
10	Josephsons effect, DC and AC squids, introduction to high Tc superconductors.	1
11	LASERS and MASERS: Spontaneous and stimulated emission, Einstein A and B coefficients, population inversion	2
12	He, Ne and Ruby lasers	2
13	Ammonia and Ruby masers	2
14	Holography and optical fibre: optical fibre- physical structure, basic theory, type of modes,	2
15	characteristics of optical fibre and applications	2
16	Illumination: laws of illumination, luminous flux, luminous intensity, candle power, brightness	2
	Total	32

Practical		
Sr.	Topic	No. of

No.		Practicals
1	To verify law of transverse vibrations along a string using electrical tuning fork	2
2	To determine e/m of electron using magnetron valve method	2
3	Determine dielectric constant of material using De Sautys bridge	2
4	Study the variation of magnetic field with distance along the axis of a current carrying circular coil and to determine the radius of the coil	3
5	Determine the energy band gap in a semiconductor using a p-n junction diode	1
6	Study the LCR circuit	1
7	Find the wave length of light by using prism and spectrometer	2
8	Determine the low resistance using Carey Foster bridge without calibrating the bridge wire.	3
	Total	16

SEMESTER – 3

Sr. No.	Course Name	Course No.	Credit	L	P	T
3	Engineering Chemistry	AS3.3	3(2+1)	2	1	3

Objective

To make the students acquainted with applications of chemistry in engineering and different chemical processes in agricultural and food engineering

Theory

Phase rule: phase, component, degree of freedom, application to one component system, viz. water system, sulphur system, two component system, viz. pb-Ag system, desilverisation of Pb;

Colloids: classification, properties like optical activity-Tyndall effect, Brownian movement, electrical properties –electrophoresis, causes, types and methods of prevention- proper designing;

Corrosion: cathodic protection using pure metal and metal alloys, use of inhibitors

Water: temporary and permanent hardness, disadvantages of hard water, scale and sludge formation of boilers, boiler corrosion, basic idea on thermo-gravimetric analysis, polarographic analysis, nuclear radiation, detectors and analytical applications of radio-active materials, discovery of isotopes and new elements, release of atomic energy, radio-active tracer and carbon dating;

Fuels: classifications, calorific value and its determination by bomb calorimeter

Principles of food chemistry: Lipids, proteins, carbohydrates and their classifications, vitamins and their importance;

Enzymes and co-enzymes important in food processing and storage, their use in manufacturing of ethanol and acetic acid by fermentation method;

Introduction to food preservatives, definition, types natural and artificial preservative and its use, colouring and flavoring reagents of foods

Lubricants: classifications, properties-viscosity, flash point and fire point mechanism, thick film, thin film and extreme pressure, neutralization point, saponification number and mechanical stability;

Type of polymerization with examples (addition, free radical); Different properties of polymers-chemical resistance, crystallinity;

Polymers: effect of heat on polymers, general use, basic principles of determination of molecular weight by viscosity methods, basic principles of determination of molecular weight by light scattering methods;

Introduction to IR spectroscopy: basic principles of spectroscopy, Beer-Lamberts law, types of vibration, symmetric, asymmetric vibration and its type, absorbances of different functional group in IR.

Practical

To determine of temporary and permanent hardness of water by EDTA method; To study the different types of fuels and compare their characteristics; To study different types of foods and their ingredients; To study the different types of food preservatives and their active principles; To estimate chloride in water sample; To estimate dissolved oxygen in water sample; To estimate chloride in water samples; To study the different properties of lubricants; To determine λ_{max} and verification of Beer-Lambert law.

Planning of lectures		
S.No	Topics to be covered in Lecture	Proposed No. of Lectures
1	Phase rule: phase, component, degree of freedom, application to one component system, viz. water system, sulphur system, two component systems.	1
2	Colloids: classification, properties like optical activity-Tyndall effect, Brownian movement.	1
3	Electrical properties of Colloids—electrophoresis, causes, types and methods of prevention- proper designing.	2
4	Corrosion: cathodic protection using pure metal and metal alloys, use of inhibitors.	2
5	Water: temporary and permanent hardness, disadvantages of hard water, scale and sludge formation of boilers, boiler corrosion.	2
6	Basic idea on thermo-gravimetric analysis, polarographic analysis,	1
7	Nuclear radiation, detectors and analytical applications of radio-active materials, discovery of isotopes and new elements, release of atomic energy, radio-active tracer and carbon dating;	3
8	Fuels: classifications, calorific value and its determination by bomb calorimeter.	1
9	Principles of food chemistry: Lipids, proteins, carbohydrates and their classifications, vitamins and their importance.	3
10	Enzymes and co-enzymes important in food processing and storage, their use in manufacturing of ethanol and acetic acid by fermentation method;	2
11	Introduction to food preservatives, definition, types of natural and artificial preservative and its use, colouring and flavoring reagents of foods.	3
12	Lubricants: classifications, properties-viscosity, flash point and fire point mechanism, thick film, thin film and extreme pressure, neutralization point, saponification number and mechanical stability;	3
13	Type of polymerization with examples (addition, free radical); Different properties of polymers-chemical resistance, crystallinity;	2
14	Polymers: effect of heat on polymers, general use, basic principles of determination of molecular weight by viscosity methods, basic principles	3

	of determination of molecular weight by light scattering methods.	
15	Introduction to IR spectroscopy: basic principles of spectroscopy	1
16	Beer-Lamberts law, types of vibration, symmetric, asymmetric vibration and its type, absorbances of different functional group in IR.	2
Total hours		32

Planning of Practical		
S.No.	Topics	Proposed No. of Practical
1	To determine the temporary hardness of water.	1
2	To determine the Permanent hardness of water by EDTA method.	1
3	To study the different types of fuels.	1
4	To do comparative study of fuel characteristics.	1
5	To study different types of foods.	1
6	To study different food ingredients.	1
7	To study the Natural food preservatives	1
8	To study the Artificial food preservatives	1
9	To study active principles of Food preservatives.	1
10	To estimate chloride in water samples.	1
11	To estimate dissolved oxygen in water samples.	1
12	To study the different properties of lubricants. Viz. Pour Point	1
13	To study the different properties of lubricants. Viz. Flash Point.	1
14	To determine Viscosity of Liquid Lubricants.	1
15	To study the Oxidative resistance of Lubricant.	1
16	To determine λ_{max} and verification of Beer-Lambert law.	1
		16

Suggested Reading

1. Bahl B S, Bahl A. and Tuli B D. 2007. *Essentials of Physical Chemistry*. S. Chand and Co. Ltd., Delhi.
2. Finar I L. 2002. *Organic Chemistry, Vol I and II*. Pearson.
3. Glasstone S. *Elements of Physical Chemistry*. The Macmillan Company of India Limited.
4. Jain and Jain. 2016. *Engineering Chemistry*. Dhanpat Rai Publication.
5. Jain P L and Jain M. 1994. *Engineering Chemistry*. Danpat Rai publishing company Pvt. Ltd., Delhi.
6. Morrison R T, Boyd R N and Bhattacharjee S K. 2010. *Organic Chemistry*. Pearson.
7. Sharam Y R. 2013. *Elementary Organic Spectroscopy*. S Chand.

SEMESTER – 3

Sr. No.	Course Name	Course No.	Credit	L	P	T
4	Engineering Mechanics	FMPE 3.4	3(2+1)	2	1	3

Objective

To make the students acquainted with the principles of engineering mechanics and the

calculation of different stresses to be helpful for design of engineering structures

Theory

Basic concepts of engineering mechanics, statics, dynamics, kinetics, scalar quantities, vector quantities, systems of units; Composition and resolution of forces, analytical method, graphical method; Laws of forces, moments and their application, levers, parallel forces and couples; Equilibrium of forces, free body diagrams, Centre of gravity (CG) of simple geometrical figures, CG by moments, plane figures, axis of references, CG of symmetric sections, unsymmetrical sections, solid bodies and cut sections; Moment of inertia: methods of finding out M.I., methods of integration, M.I. of different sections, Theorem of perpendicular axes, parallel axes, M.I. of composite sections and cut sections.

Frictional forces, static friction, dynamic friction, limiting friction, normal reaction, angle of friction, coefficient of friction, laws of friction, equilibrium of a body lying in horizontal and inclined planes, ladder friction; wedge friction, screw friction, screw jack; Analysis of simple framed structures, methods of sections, for citable, methods of joints, hinged joints, roller support, vertical and inclined loads;

Simple stresses and strain, Hooke's law, Poisson's ratio, modulus of elasticity, Strain related problems Shear force and bending moment, fundamentals of shear force and bending moment, SFD and BMD of cantilever and simply supported and overhanging beams, point of contraflexure; Torsion of circular shaft, torsional effect, hoop stress, power transmitted by a shaft; Principal stresses and strain, analysis of plane and complex stress, principal planes and principal stresses, Mohr's circle, finding out principal stresses, different analysis

Practical

Problems on composition and resolution of forces; Study the moments of a force; Problems related to resultant of a concurrent-coplanar force system; Problems related to non-concurrent coplanar force system; Systems of couples in space; Problems related to centroids of composite areas; Problems on Moment of Inertia, radius of gyration of composite areas; Analysis of equilibrium of concurrent coplanar and non-concurrent coplanar force system; Problems involved with frictions; Analysis of simple trusses by methods of joints and methods of sections; Analysis of simple trusses by graphical method; Problems on simple stress and strains; Problems on shear and bending moment diagrams. Problems on stresses on beams Problems on torsion of the shafts; Analysis of plane and complex stresses

Planning of Lectures		
Sr. No	Topics to be covered in Lectures	No. of Lectures
1	Basic concepts of engineering mechanics, statics, dynamics, kinetics, scalar quantities, vector quantities, systems of units; Laws of forces	1
2	Composition and resolution of forces, analytical method, graphical method	3
3	Moments and their application, levers, parallel forces and couples; Equilibrium of forces, free body diagrams	2
4	Centre of gravity (CG) of simple geometrical figures, CG by moments, plane figures, axis of references	2
5	CG of symmetric sections, unsymmetrical sections, solid bodies and cut sections	2
6	Moment of inertia: methods of finding out M.I., methods of integration, M.I. of different sections	2
7	Theorem of perpendicular axes, parallel axes, M.I. of composite sections and cut sections	2
8	Frictional forces, static friction, dynamic friction, limiting friction, normal	1

	reaction, angle of friction, coefficient of friction, laws of friction	
9	Equilibrium of a body lying in horizontal and inclined planes, ladder friction; wedge friction, screw friction, screw jack.	3
10	Analysis of simple framed structures, methods of sections, for citable, methods of joints, hinged joints, roller support, vertical and inclined loads	3
11	Simple stresses and strain, Hooke's law, Poisson's ratio, modulus of elasticity, Strain related problems	2
12	Shear force and bending moment, fundamentals of shear force and bending moment, SFD and BMD of cantilever and simply supported and overhanging beams, point of contra-flexure	4
13	Torsion of circular shaft, torsional effect, hoop stress, power transmitted by a shaft	2
14	Principal stresses and strain, analysis of plane and complex stress, principal planes and principal Stresses, Mohr's circle, finding out principal stresses, different analysis	3
Total		32

Planning of Practical		
Sr. No	Topics to be covered in Practical	No. of Practical
1	Problems on composition and resolution of forces.	1
2	Study the moments of a force.	1
3	Problems related to resultant of a concurrent-coplanar force system.	1
4	Problems related to non-concurrent coplanar force system.	1
5	Systems of couples in space.	1
6	Problems related to centroids of composite areas.	1
7	Problems on Moment of Inertia.	1
8	Radius of gyration of composite areas.	1
9	Analysis of equilibrium of concurrent coplanar and non-concurrent coplanar force system.	1
10	Problems involved with frictions.	1
11	Analysis of simple trusses by methods of joints and methods of section.	1
12	Analysis of simple trusses by graphical method.	1
13	Problems on simple stress and strains.	1
14	Problems on stresses on beams	1
15	Problems on shear and bending moment diagrams.	1
16	Problems on torsion of the shafts.	1
17	Analysis of plane and complex stresses	1
Total		17

Suggested Reading

1. Bansal, R. K. 2005. A Text Book of Engineering Mechanics. Laxmi Publishers, New Delhi.
2. Khurmi, R. S. 2006. Strength of Materials. S. Chand Publishing.
3. Khurmi, R. S. 2018. A Text Book of Engineering Mechanics. S. Chand Publishing.
4. Prasad, I. B. 2004. Applied Mechanics and Strength of Materials. Khanna Publishers, New Delhi.
5. Prasad, I. B. 2004. Applied Mechanics. Khanna Publishers, New Delhi.

6. Sundarajan, V. 2002. Engineering Mechanics and Dynamics. Tata McGraw Hill Publishing Co. Ltd, New Delhi.
7. Timoshenko, S. and Young, D. H. 2003. Engineering Mechanics. McGraw Hill Book Co., New Delhi.

SEMESTER – 3

Sr. No.	Course Name	Course No.	Credit	L	P	T
5	Watershed Hydrology	SWCE3.5	3(2+1)	2	1	3

Course Content:

Hydrologic cycle, components; Precipitation and its forms, rainfall measurement and estimation of mean rainfall, estimation of missing rainfall, optimum number of rain gauges; Frequency analysis of point rainfall; Mass curve, hyetograph, depth-area-duration curves and intensity-duration- frequency relationship; Hydrologic processes- interception, infiltration -factors influencing, measurement and indices; Evaporation- estimation and measurement; Runoff- factors affecting, measurement, stage – discharge rating curve, estimation of peak runoff rate and volume, rational method, Cook’s method and SCS curve number method; Geomorphology of watersheds – linear, aerial and relief aspects of watersheds- stream order, drainage density and stream frequency; Hydrograph - components, base flow separation, unit hydrograph theory, s-curve, synthetic hydrograph, applications and limitations; Flood routing – channel and reservoir routing; Hydrology of dry land areas, Troll’s climatic classification; Drought- classification, causes and impacts, drought management strategy.

Practical

Visit to meteorological observatory and study of different instruments; Study of optimal rain gauge network; Study of intensity - frequency - duration curves; Study of depth - area – duration curve; Analysis of rainfall data and estimation of mean rainfall by different methods; Analysis of frequency of hydrologic data and estimation of missing data, test for consistency of rainfall records; Computation of infiltration indices; Computation of peak runoff and runoff volume by Cook’s method and rational formula; Computation of runoff volume by SCS curve number method; Study of stream gauging instruments- current meter and stage level recorder; Study and determination of geomorphic parameters of watersheds; Study of runoff hydrograph and separation of base flow and surface flow ; Study of unit hydrograph; Study of synthetic hydrograph ; Study of flood routing; Study of various discharge measuring devices.

Planning of lectures		
S.No.	Topics to be covered in Lecture	Proposed No. of Lectures
1	Hydrologic cycle, components	1
2	Precipitation and its forms	1
3	Rainfall measurement and estimation of mean rainfall,	2
4	Estimation of missing rainfall, optimum number of rain gauges	2
5	Frequency analysis of point rainfall; Mass curve, hyetograph,	3
6	Depth-area-duration curves and intensity duration- frequency relationship	2
7	Hydrologic processes- interception, infiltration -factors influencing,	2

	measurement and indices	
8	Evaporation- estimation and measurement	2
9	Runoff- factors affecting, measurement, stage – discharge rating curve	2
10	Estimation of peak runoff rate and volume, rational method, Cook’s method and SCS curve number method	3
11	Geomorphology of watersheds – linear, aerial and relief aspects of watersheds- stream order, drainage density and stream frequency	3
12	Hydrograph - components, base flow separation	2
13	Unit hydrograph theory, s-curve, synthetic hydrograph, applications and limitations	2
14	Flood routing – channel and reservoir routing	2
15	Hydrology of dry land areas, Troll’s climatic classification	1
16	Drought- classification, causes and impacts, drought management strategy	2
	Total	32
Practicals		
S.No.	Topic	No. of Practicals
1	Visit to meteorological observatory and study of different instruments	1
2	Study of optimal rain gauge network	1
3	Study of intensity - frequency - duration curves; Study of depth - area – duration curve;	2
4	Analysis of rainfall data and estimation of mean rainfall by different methods;	1
5	Analysis of frequency of hydrologic data and estimation of missing data, test for consistency of rainfall records;	1
6	Computation of infiltration indices;	1
7	Computation of peak runoff and runoff volume by Cook’s method and rational formula; Computation of runoff volume by SCS curve number method;	2
8	Study of stream gauging instruments- current meter and stage level recorder;	1
9	Study and determination of geomorphic parameters of watersheds;	1
10	Study of runoff hydrograph and separation of base flow and surface flow	1
11	Study of unit hydrograph;	1
12	Study of synthetic hydrograph ;	1
13	Study of flood routing;	1
14	Study of various discharge measuring devices.	1
	Total	16

Suggested Reading

1. Chow V T, Maidment D R and Mays L W. 2010. *Applied Hydrology*. McGraw Hill, New York.
2. Jaya Rami Reddy P. 2011. *A Text Book of Hydrology*. University Science Press, New Delhi.
3. Linsley R K, Kohler M A, and Paulhus J L H. 1984. *Hydrology for Engineers*. McGraw-Hill Publishing Co., Japan.
4. Panigrahi B and Panigrahi K. 2016. *Engineering Hydrology*. New India Publishing Agency, New Delhi

5. Mutreja K N. 1990. *Applied Hydrology*. Tata McGraw-Hill Publishing Co., New Delhi.
6. Raghunath H M. 2006. *Hydrology : Principles Analysis and Design*. 2nd Edition, New Age International (P) Limited Publishers, New Delhi.
7. Subramanya K. 2008. *Engineering Hydrology*. 3rd Edition, Tata McGraw-Hill, New Delhi.
8. Suresh R. 2005. *Watershed Hydrology*. Standard Publishers and Distributors, Delhi.
9. Varshney R S. 1986. *Engineering Hydrology*. Nem Chand and Brothers, Roorkee, U.P.
10. Garg S K. 1998. *Hydrology and Water Resources Engineering*. Khanna Publishers, Delhi.
11. Das G. 2000. *Hydrology and Soil Conservation Engineering*. PHI, New Delhi.

SEMESTER – 3

Sr. No.	Course Name	Course No.	Credit	L	P	T
6	Fluid Mechanics and Open Channel Hydraulics	IDE3.6	3(2+1)	2	1	3

Objective

To make the students acquainted with the behaviour of fluids at rest and in motion and to enable them to apply the principles to design simple fluid mechanical systems in engineering

Theory

Properties of fluids: ideal and real fluid, units; Pressure and its measurement, Pascal's law, pressure forces on plane and curved surfaces, centre of pressure, pressure diagram, application of hydrostatics in engineering structures; Buoyancy, Archimede's principle, metacentre and metacentric height, condition of floatation and stability of submerged and floating bodies

Kinematics of fluid flow: Lagrangian and Eulerian description of fluid motion, continuity equation, path lines, streak lines and stream lines, stream function, velocity potential and flow net. Types of fluid flow, translation, rotation, circulation and vorticity, vortex motion; Dynamics of fluid flow, Bernoulli's theorem, venturimeter, orifice meter and pitot tube, siphon Flow through orifices (measurement of discharge, measurement of time), flow through mouthpieces; Flow over notches, flow over weirs, end contraction of rectangular weirs, ventilation of weirs, various types of nappe; laminar and turbulent flow in pipes, general equation for head loss Darcy equation, Moody's diagram, minor and major hydraulic losses through pipes and fittings, flow through network of pipes, hydraulic gradient and energy gradient, Chezy's formula for loss of head in pipes, flow through simple and compound pipes, transmission of power through pipes;

Open channel design and hydraulics: Chezy's formula, Bazin's formula, Kutter's, Manning's formula, best hydraulic section, velocity and pressure profiles in open channels, hydraulic jump; Discharge measurement in open channels: current meter; Dimensional analysis and similitude: Rayleigh's method and Buckingham's 'pi' theorem, types of similarities, dimensionless numbers; Introduction to fluid machinery

Practical

Study of manometers and pressure gauges; Study of transmissibility of liquid pressure; Study of various types of flow such as laminar flow, uniform flow, steady flow, vertex flow, rotational flow; Determination of meta-centric height; Verification of Bernoulli's theorem, determination of coefficient of discharge of venturi-meter and orifice meter; Determination of

coefficient of friction in pipeline; Determination of coefficient of discharge for rectangular and triangular notch; Determination of coefficient of discharge, coefficient of velocity and coefficient of contraction for flow through orifice; Determination of coefficient of discharge for mouth piece; Determination of efficiency of hydraulic ram; Measurement of velocity by current meter; Study of open channel flow: velocity distribution in open channels and determination of Manning's coefficient of Rugosity and Chezy's roughness coefficient; Study of various types of models and prototypes: geometrical, kinematic and dynamic similarities; Study on non-dimensional constants such as Froude's number and Reynold's number; Study of various types of pumps and its components.

Theory

Planning of lectures		
S.No.	Topics to be covered in Lecture	Proposed No. of Lectures
1	Properties of fluids: ideal and real fluid, units	2
2	Pressure and its measurement	2
3	Pascal's law, pressure forces on plane and curved surfaces, centre of pressure, pressure diagram	2
4	Application of hydrostatics in engineering structures	1
5	Buoyancy, Archimede's principle, metacentre and metacentric height, condition of floatation and stability of submerged and floating bodies	3
6	Kinematics of fluid flow: Lagrangian and Eulerian description of fluid motion, continuity equation, path lines, streak lines and stream lines, stream function, velocity potential and flow net	4
7	Types of fluid flow, translation, rotation, circulation and vorticity, vortex motion	1
8	Dynamics of fluid flow, Bernoulli's theorem, venturimeter, orifice meter and pitot tube, siphon Flow through orifices (measurement of discharge, measurement of time), flow through mouthpieces; Flow over notches, flow over weirs, end contraction of rectangular weirs, ventilation of weirs, various types of nappe;	5
9	laminar and turbulent flow in pipes, general equation for head loss Darcy equation, Moody's diagram, minor and major hydraulic losses through pipes and fittings, flow through network of pipes, hydraulic gradient and energy gradient	2
10	Chezy's formula for loss of head in pipes, flow through simple and compound pipes, transmission of power through pipes	2
11	Open channel design and hydraulics: Chezy's formula, Bazin's formula, Kutter's, Manning's formula, best hydraulic section, velocity and pressure profiles in open channels, hydraulic jump	3
12	Discharge measurement in open channels: current meter	2
13	Dimensional analysis and similitude: Rayleigh's method and Buckingham's 'pi' theorem, types of similarities, dimensionless numbers	2
14	Introduction to fluid machinery	1
		32

Practical

Planning of Practical		
S.No.	Topics	Proposed No. of Practical
1	Study of manometers and pressure gauges	1
2	Study of transmissibility of liquid pressure	1
3	Study of various types of flow such as laminar flow, uniform flow, steady flow, vertex flow, rotational flow	1
4	Determination of meta-centric height	1
5	Verification of Bernoulli's theorem, determination of coefficient of discharge of venturi-meter and orifice meter	1
6	Determination of coefficient of friction in pipeline	1
7	Determination of coefficient of discharge for rectangular and triangular notch	2
8	Determination of coefficient of discharge, coefficient of velocity and coefficient of contraction for flow through orifice	1
9	Determination of coefficient of discharge for mouth piece	1
10	Determination of efficiency of hydraulic ram	1
11	Measurement of velocity by current meter	1
12	Study of open channel flow: velocity distribution in open channels and determination of Manning's coefficient of Rugosity and Chezy's roughness coefficient	1
13	Study of various types of models and prototypes: geometrical, kinematic and dynamic similarities	1
14	Study on non-dimensional constants such as Froude's number and Reynold's number	1
15	Study of various types of pumps and its components	1
		16

Suggested Reading

1. Bansal R K. 2019. *A Text book of Fluid Mechanics*. Laxmi Publications, New Delhi.
2. Ramanathan S. 2011. *Hydraulics, Fluid Mechanics & Hydraulic Machines*. Dhanpat Rai & Sons, Delhi.
3. Khurmi R S and Khurmi N. 1987. *Hydraulics, Fluid Mechanics and Hydraulic Machines*. S. Chand & Co. Ltd., New Delhi.
4. Modi P N and Seth S M. 2017. *Hydraulics & Fluid Mechanics including hydraulic machines*. Standard Book House, Delhi.

SEMESTER – 3

Sr. No.	Course Name	Course No.	Credit	L	P	T
7.	Engineering Properties of Agricultural Produce and Food Science	PFE-3.7	3(2+1)	2	1	3

Objective

To make the students acquainted with the different engineering properties of agricultural produce and to help them understand the importance of these properties in handling, processing and storage

Course content: Theory:

Different engineering properties of food and their importance; Application of engineering properties in handling, processing and storage; Physical properties, viz. shape, size, roundness, sphericity, volume, density, porosity, specific gravity, surface area; Colour properties, CIE colour model.

Thermal properties, viz. heat capacity, specific heat, thermal conductivity, thermal diffusivity, heat of respiration, co-efficient of thermal expansion; Electrical and dielectric properties as resistance, capacitance, dielectric loss factor, loss tangent, and dielectric constant; Frictional properties, viz. static friction, kinetic friction, rolling resistance, angle of internal friction, angle of repose, flow of bulk granular materials; Aero-dynamic characteristics such as drag coefficient, terminal velocity.

Rheological characteristics of food, elastic, plastic and viscous behaviour, visco-elasticity; rheological models to explain food characteristics; Fluid behaviour as Newtonian, non-Newtonian, pseudo-plastic, dilatant, thixotropic, rheopectic and Bingham plastic; Textural characteristics of foods.

Non-destructive methods of quality determination of foods; Principles of machine vision systems, spectroscopy, hyperspectral imaging and acoustic techniques.

Introduction to food science and food technology; Biochemical reactions involved in food processing and storage; Food spoilage agents, general methods for food preservation (physical, chemical and biological methods); Food microbiology: Classification of microorganisms, multiplication of bacteria, Different beneficial and harmful microorganisms in relation to food preservation and spoilage, industrial bacteriology and food fermentation.

Practical:

Determination of the size of grains, fruits and vegetables using measuring instruments and using projection system; Determination of the shape (sphericity and roundness); Determination of the bulk and particle volume, bulk and particle density, specific gravity and porosity of grains; Determination of the volume, density and specific gravity of large individual objects (F and V); Determination of the surface area of the F and V; Determination of angle of repose, co-efficient of friction of different grains on different surfaces and angle of internal friction; To study the terminal velocity of grains and separating behavior of grains in a vertical wind tunnel; Determination of specific heat and thermal conductivity of some food grains; Determination of electrical properties of food materials; Determination of hardness of food materials; Determination of viscosity of food; Study and comparison of colour of food materials; Determination of carbohydrates; Determination of total nitrogen; Determination of oil content; Determination of ash content; Study of different types of microorganisms and microbiological examination of food products.

Planning of lectures		
Sr.	Topics to be covered in Lecture	Proposed

No.		No. of Lectures
1.	Different engineering properties of food and their importance; Application of engineering properties in handling, processing and storage.	2
2.	Physical properties, viz. shape, size, roundness, sphericity, volume, density, porosity, specific gravity, surface area; Colour properties, CIE colour model.	4
3.	Thermal properties, viz. heat capacity, specific heat, thermal conductivity, thermal diffusivity, heat of respiration, co-efficient of thermal expansion; Electrical and dielectric properties as resistance, capacitance, dielectric loss factor, loss tangent, and dielectric constant.	4
4.	Frictional properties, viz. static friction, kinetic friction, rolling resistance, angle of internal friction, angle of repose, flow of bulk granular materials; Aero-dynamic characteristics such as drag coefficient, terminal velocity.	4
5.	Rheological characteristics of food, elastic, plastic and viscous behaviour, visco-elasticity; rheological models to explain food characteristics; Fluid behaviour as Newtonian, non-Newtonian, pseudo-plastic, dilatant, thixotropic, rheopectic and Bingham plastic; Textural characteristics of foods.	6
6.	Non-destructive methods of quality determination of foods; Principles of machine vision systems, spectroscopy, hyperspectral imaging and acoustic techniques.	4
7.	Introduction to food science and food technology; Biochemical reactions involved in food processing and storage; Food spoilage agents, general methods for food preservation (physical, chemical and biological methods).	4
8.	Food microbiology: Classification of microorganisms, multiplication of bacteria, Different beneficial and harmful microorganisms in relation to food preservation and spoilage, industrial bacteriology and food fermentation.	4
Total		32
Sr. No.	Topic	No. of Practicals
1.	Determination of the size of grains, fruits and vegetables using measuring instruments and using projection system; Determination of the shape (sphericity and roundness);	2
2.	Determination of the bulk and particle volume, bulk and particle density, specific gravity and porosity of grains;	1
3.	Determination of the volume, density and specific gravity of large individual objects (F and V); Determination of the surface area of the F and V;	1
4.	Determination of angle of repose, co-efficient of friction of different grains on different surfaces and angle of internal friction;	1
5.	To study the terminal velocity of grains and separating behavior of grains in a vertical wind tunnel;	1
6.	Determination of specific heat and thermal conductivity of some food grains;	2
7.	Determination of electrical properties of food materials;	1
8.	Determination of hardness of food materials;	1

9.	Determination of viscosity of food;	1
10.	Study and comparison of colour of food materials;	1
11.	Determination of carbohydrates; Determination of total nitrogen; Determination of oil content; Determination of ash content;	3
12.	Study of different types of microorganisms and microbiological examination of food products.	1
Total		16

Suggested Readings

1. Mohesin, N. N. 1980. Physical Properties of Plants & Animals. Gordon & Breach Science Publishers, New York.
2. Rao, M. A. and Rizvi, S. H. 1995. Engineering Properties of Foods. Marcel Dekker Inc. New York.
3. Serpil, S. and Servet, G. S. 2005. Physical Properties of Foods. Springer Science+Business Media, LLC, 233 Spring Street, New York.
4. Singhal, O. P. and Samuel, D. V. K. 2003. Engineering Properties of Biological Materials. Saroj Prakasan, New Delhi.

SEMESTER – 3

Sr. No.	Course Name	Course No.	Credit	L	P	T
8	Farm Machinery & Equipment - I	FMPE 3.8	3(2+1)	2	1	3

Objective

To make the students acquainted with the basic construction and operational features of different farm machineries used in operations such as seed-bed preparation, sowing, planting and transplanting, etc., and their economics of operation

Theory

Introduction to farm mechanization; Classification of farm machines; Unit operations in crop production; Identification and selection of machines for various operations on the farm.

Materials used in construction of farm machines; Heat treatment processes and their use in farm machines; Properties of materials used for critical and functional components of agricultural machines; Different types of steels and alloys for agricultural applications; Identification of heat treatment processes specially for the agricultural machinery components.

Seed-bed preparation and its classification; Land reclamation and earth moving equipment; Machines used for primary tillage, secondary tillage, rotary tillage, deep tillage and minimum tillage, viz. mould-board plough, disc plough, chisel plough, sub-soiler, harrows, puddler, cultivators, identification of their major functional components; Attachments with tillage machinery; Hitching systems and controls.

Calculation of field capacities and field efficiency; Draft of tillage tools and calculations for power requirement for the tillage machines; Calculation for economics of machinery usage; Comparison of ownership with hiring of machines.

Sowing, planting and transplanting equipment, viz. seed drills, no-till drills, strip-till drills, different types of planters, bed-planters; Planting equipment for crops like sugarcane, potato; Furrow openers and metering systems in drills and planters; Calibration of seed-drills/ planters; Adjustments during operation.

Testing and Evaluation of tillage and sowing equipment and their test codes.

Practical

Familiarization with different farm implements and tools; Study of hitching systems; Study on draft measurement; Study of different problems on machinery management.; Study of primary tillage machinery- types, construction, operation, adjustments and calculations of power and draft requirements; Study of secondary tillage machinery- types, construction, operation, adjustments and calculations of power and draft requirements; Study of different types of puddlers and determination of puddling index in the field; Study of sowing and planting equipment- construction, types, calculation for calibration and adjustments; Study of seed drill and its calibration; Study of different types of metering mechanisms used in seed drills and planters; Study of paddy transplanters; Study of various pre-germinated paddy seeder; Study of vegetable transplanters; Identification of materials of construction in agricultural machinery and study of material properties; Testing and Evaluation of tillage and sowing equipment; Visit to a site to observe field operations of paddy transplanters; Visit to an implement manufacturing unit.

Planning of Lectures		
Sr. No	Topics to be covered in Lectures	No. of Lectures
1	Introduction to farm mechanization, Classification of farm machines.	2
2	Unit operations in crop production, Identification and selection of machines for various operations on the farm.	2
3	Introduction to materials used in construction of farm machines, Heat treatment processes and their use in farm machines.	2
4	Familiarization with properties of materials used for critical and functional components of agricultural machines, Different types of steels and alloys for agricultural applications, Identification of heat treatment processes especially for the agricultural machinery components.	2
5	Introduction to seed-bed preparation and its classification.	2
6	Introduction to machines used for primary tillage, secondary tillage, rotary tillage, deep tillage and minimum tillage, viz. mould-board plough, disc plough, chisel plough, sub-soiler, harrows, puddler, cultivators, etc.	3
7	Identification to major functional components of tillage machinery, attachments of the machinery with tractor and adjustments during operation.	2
8	Introduction to hitching systems and controls of farm machinery.	2
9	Familiarization with land reclamation and earth moving equipment.	2
10	Calculation of field capacities and field efficiency.	2
11	Measurement of draft of tillage machinery and calculations for power requirement for the tillage machines.	2
12	Calculation for economics of machinery usage, comparison of ownership with hiring of machines.	2
13	Introduction to sowing, planting and transplanting equipment, viz. seed drills, no-till drills, strip-till drills.	3
14	Introduction to different types of planters, bed-planters and other planting equipment for crops like sugarcane and potato. Calibration of seed drills/planters.	2

15	Study of different types of furrow openers and metering systems in drills and planters, Adjustments during operation.	2
Total		32

Planning of Practical		
Sr. No	Topics to be covered in Practical	No. of Practical
1	Familiarization with different farm implements and tools.	1
2	Study of hitching systems.	1
3	Study on draft measurement.	1
4	Study of different problems on machinery management.	1
5	Study of primary tillage machinery- types, construction, operation, adjustments and calculations of power and draft requirements.	1
6	Study of secondary tillage machinery- types, construction, operation, adjustments and calculations of power and draft requirements.	2
7	Study of different types of puddlers and determination of puddling index in the field.	1
8	Study of sowing and planting equipment- construction, types, calculation for calibration and adjustments.	1
9	Study of seed drill and its calibration, Study of different types of metering mechanisms used in seed drills and planters.	1
10	Study of paddy transplanters, Study of various pre-germinated paddy seeder.	1
11	Study of vegetable transplanters.	1
12	Identification of materials of construction in agricultural machinery and study of material properties.	1
13	Testing and Evaluation of tillage and sowing equipment.	1
14	Visit to a site to observe field operations of paddy transplanters.	1
15	Visit to an implement manufacturing unit.	1
Total		16

Suggested Reading

1. Jain, S. C. and Phillips, G. 2003. Farm Machinery - An Approach. Standard Publishers and Distributors.
2. Kepner, R. A., Bainer, R. and Barger, E. L. 2005. Principles of Farm Machinery. CBS Publishers and Distributors.
3. Lal, Radhey and Datta, A. C. 1978. Agricultural Engineering through worked out examples. Saroj Prakashan, Allahabad.
4. Nakra, C. P. 2003. Farm Machines and Equipment. Dhanpat Rai and Publishing Co.
5. Smith, H. P. and Wilkes, L. H. 2011. Farm Machinery and Equipment. McGraw Hill Publication, New York.
6. Srivastav, A. K., Goering, C. E. and Rohrbach, R. P. 2005. Engineering Principles of Agricultural Machines. ASAE. St. Joseph, Mich.
7. Srivastava, A. C. 1991. Elements of Farm Machinery. Oxford and IBH Publication.
8. Srivastava, T. K. 2007. A Work Book on Practical Farm Machinery (Vol. I and II). Saroj Prakashan, Allahabad.

Sr. No.	Course Name	Course No.	Credit	L	P	T
9	Physical Education, First Aid and Yoga Practices	AEC-III	2 (0+2)	0	2	2

Course Content:

- Yoga; History of Yog, Types of Yog, Introduction to Yog,
- Asanas (Definition and Importance) Padmasan,
- Gaumukhasan, Bhadrasan, Vajrajasan, Shashankasan, Pashchimotasan, Ushtrasan, Tadasan, Padhastasan, Ardhchandrasan, Bhujangasan, Utanpadasan, Sarvangasan, Parvatasan, Patangasan, Shishupalanasan – left leg-right leg,
- Pavanmuktasan, Halasan, Sarpasan, Ardhhanurasan, Sawasan
- Suryanamskar Pranayama (Definition and Importance) Omkar, Suryabhedan, Chandrabhedan, Anulom Vilom, Shitali, Shitkari, Bhastrika, Bhramari
- Meditation (Definition and Importance), Yogic Kriyas (Kapalbhati), Tratak, Jalneti and Tribandh
- Mudras (Definition and Importance) Gyanmudra, Dhyanmudra, Vayumudra, Akashmudra, Pruthvimudra, Shunyamudra, Suryamudra, Varunmudra, Pranmudra, Apanmudra, Vyanmudra, Uddanmudra
- Role of yoga in sports
- Teaching of Asanas – demonstration, practice, correction and practice.

History of sports and ancient games, Governance of sports in India; Important national sporting events; Awards in Sports; History, latest rules, measurements of playfield, specifications of equipment, skill, technique, style and coaching of major games (Cricket, football, table Tennis, Badminton, Volleyball, Basketball, Kabaddi and Kho-Kho) and Athletics

Need and requirement of first aid. First Aid equipment and upkeep. First AID Techniques, First aid related with respiratory system. First aid related with Heart, Blood and Circulation. First aid related with Wounds and Injuries. First aid related with Bones, Joints Muscle related injuries. First aid related with Nervous system and Unconsciousness. First aid related with Gastrointestinal Tract. First aid related with Skin, Burns. First aid related with Poisoning. First aid related with Bites and Stings. First aid related with Sense organs, Handling and transport of injured traumatized persons. Sports injuries and their treatments.

Practical

Physical education; Training and Coaching - Meaning & Concept; Methods of Training; aerobic and aerobic exercises; Calisthenics, weight training, circuit training, interval training, Fartlek training; Effects of Exercise on Muscular, Respiratory, Circulatory & Digestive systems; Balanced Diet and Nutrition: Effects of Diet on Performance; Physiological changes due to ageing and role of regular exercise on ageing process; Personality, its dimensions and types; Role of sports in personality development; Motivation and Achievements in Sports; Learning and Theories of learning; Adolescent Problems & its Management; Posture; Postural Deformities; Exercises for good posture.

Planning of Practicals		
Sr. No	Topics to be covered in Practical	No. of Practical
1.	Physical education; Training and Coaching - Meaning & Concept; Methods of Training	6
2.	Aerobic and aerobic exercises; Calisthenics, weight training, circuit training, interval training, Fartlek training	6

3.	Effects of Exercise on Muscular, Respiratory, Circulatory & Digestive systems	5
4.	Balanced Diet and Nutrition: Effects of Diet on Performance; Physiological changes due to ageing and role of regular exercise on ageing process	5
5.	Personality, its dimensions and types; Role of sports in personality development; Motivation and Achievements in Sports	5
6.	Learning and Theories of learning; Adolescent Problems & its Management; Posture; Postural Deformities; Exercises for good posture.	5
Total		30

SEMESTER – 3

Sr. No.	Course Name	Course No.	Credit	L	P	T
10	National Service Scheme (NSS- III)/ OR National cadet corps (NCC- III)	AEC-IX OR AEC-X	1*(0+1)	0	1	0

FACULTY OF AGRICULTURAL ENGINEERING				
Undergraduate Course Curriculum				
Sr. No.	Course Number	Course Title	Credit Hours	Total Credit Hours
Second Year				
SEMESTER - IV				
1	AS4.1	Engineering Mathematics-II	3 (3+0)	24 (17+7) +1 * Non Gradial
2	SWCE4.2	Theory of Structures	2 (1+1)	
3	SWCE4.3	Building Construction & Cost Estimation	2 (2+0)	
4	SWCE4.4	Soil Mechanics	2 (1+1)	
5	SWCE4.5	Soil and Water Conservation Engineering	3 (2+1)	
6	FMPE4.6	Farm Machinery & Equipment II	3 (2+1)	
7	REE4.7	Renewable Energy Sources	3 (2+1)	
8	PFE4.8	Post-harvest Engineering of Cereals, Pulses and Oilseeds	3 (2+1)	
9	MDC - II	Entrepreneurship Development and Business Management	3 (2+1)	
10	AEC-XI or AEC-XII	National Service Scheme (NSS-IV) or National Cadet Corps(NCC-IV)	1*(0+1)	
Post-IV Semester				
11	Int4.10	Internship (for 10 weeks, only for exit option for award of UG-Diploma)	10 (0+10)	

SEMESTER – 4

Sr. No.	Course Name	Course No.	Credit	L	P	T
1	Engineering Mathematics-II	AS4.1	3(3+0)	3	0	3

Objective

To make the students acquainted with the application of various advanced mathematics such as vector calculus, Fourier series and Laplace transform and applications of numerical methods in engineering

Theory

Vector calculus: scalar and vector point functions, vector differential operator Del, gradient of scalar point function, divergent and curl of vector point function and their physical interpretations, line, surface and volume integrals, Green's, Stock's and Divergence theorem (without proofs), functions of a complex variable, limit, continuity and analytic function, Cauchy-Reimann equations, harmonic functions

Fourier series: periodic functions, Euler's formulae, functions having arbitrary period, even and odd

functions, half range series expansion, series expansion of functions with finite discontinuity; Laplace

Transform: rules for Laplace transform and inverse Laplace transform, applications to find solutions of ordinary and simultaneous differential equations

Numerical Methods: finite difference operators and their relationship, factorial notation. Newton's forward and backward interpolation formula, Newton's divide difference interpolation and Lagrange's interpolation formula, numerical differentiation and integration rule, numerical solutions of ODE by Taylor's series, Euler's and modified Euler's method, Runge-Kutta method of order four

Planning of Lectures		
Sr. No	Topics to be covered in lecture	Proposed No. of Lectures
1.	scalar and vector point functions, vector differential operator Del, gradient of scalar point function, divergent and curl of vector point function and their physical interpretations	5
2.	line, surface and volume integrals, Green's, Stock's and Divergence theorem (without proofs)	3
3.	functions of a complex variable, limit, continuity and analytic function, Cauchy-Reimann equations, harmonic functions.	6
4.	periodic functions, Euler's formulae, functions having arbitrary period, even and odd functions	5
5.	half range series expansion, series expansion of functions with finite discontinuity.	5
6.	rules for Laplace transform and inverse Laplace transform	5
7.	applications to find solutions of ordinary and simultaneous differential equations.	3
8.	finite difference operators and their relationship, factorial notation.	4

9.	Newton's forward and backward interpolation formula, Newton's divide difference interpolation and Lagrange's interpolation formula	6
10.	numerical differentiation and integration rule, numerical solutions of ODE by Taylor's series, Euler's and modified Euler's method, Runge-Kutta method of order four	6
Total		48

Suggested Reading

1. Grewal B S. 2004. *Higher Engineering Mathematics*. Khanna Publishers Delhi.
2. Narayan S. 2004. *A Text Book of Vector*. S. Chand and Co. Ltd. New Delhi.
3. Narayan S. 2004. *Differential Calculus*. S. Chand and Co. Ltd. New Delhi.
4. Narayan S. 2004. *Integral Calculus*. S. Chand and Co. Ltd. New Delhi. Ramana B V. 2008. *Engineering Mathematics*. Tata McGraw-Hill. New Delhi.

SEMESTER – 4

Sr. No.	Course Name	Course No.	Credit	L	P	T
2	Theory of Structures	SWCE4.2	2(1+1)	1	1	2

Objectives

To make the students acquainted with the principles of structural design and to enable them to design small and medium RCC and steel structures.

Theory

Types of Load and use of BIS code

Design of steel structures- specifications, use of IS code (IS 800-2007) and steel table, design of steel sections under tension, compression and bending, use of any one design software such as Staad Pro, Etabs, etc. for design of roof truss;

Design of RCC structures- specifications, use of IS code (IS 456-2000), Analysis and design of singly and doubly reinforced sections, design of beams, design of one way and two way slabs, columns and foundations, design considerations for retaining walls and silos, use of design software for simple RCC structures

Practical

Design and drawing of steel roof truss including tension member, compression member, and member under bending; use of design softwares; Design and drawing of RCC building, including single reinforced beam, double reinforced beam, one-way slab, two way slabs, columns and foundations; use of design softwares for simple RCC structures

Planning of lectures		
SN	Topics to be covered in lecture	Proposed No. of Lecture
1	Types of Load and use of BIS code	2

2	Design of steel structures- specifications, use of IS code (IS 800-2007) and steel table	3
3	Design of steel sections under tension	2
4	Design of steel sections under compression	2
5	Design of steel sections under bending	2
6	Use of any one design software such as Staad Pro, Etabs, etc. for design of roof truss	4
7	Design of RCC structures- specifications, use of IS code (IS 456-2000)	4
8	Analysis and design of singly and doubly reinforced sections	3
9	Design of beams	2
10	Design of one way and two way slabs	4
11	Columns and foundations	2
12	Design considerations for retaining walls and silos	2
13	Use of design software for simple RCC structures	4
	Total	36

Practical

Practical		
Sr.No.	Topic	No. of Practical's
1	Design and drawing of steel roof truss including tension member	2
2	Design and drawing of steel roof truss including compression member	2
3	Design and drawing of steel roof truss including member under bending	2
4	Use of design softwares	4
5	Design and drawing of RCC building	2
6	Design & analysis singly reinforced beam	1
7	Design & analysis doubly reinforced beam	1
8	Design one-way slab	2
9	Design two way slabs	2
10	Design columns and foundations	2
11	Use of design softwares for simple RCC structures	4
	Total	

Suggested Reading

1. Bhavikatti S S. 2014. *Design of Steel Structures: By Limit State Method as Per IS: 800-2007*. I K International Publishing House Pvt. Ltd.
2. Duggal S K. 2017. *Limit State Design of Steel Structures*. McGraw Hill Education.
3. Punmia B C, Jain A K and Jain A K. 2016. *Limit State Design of Reinforced Concrete*. Laxmi Publications.
4. Raju N K. 2019. *Design of Reinforced Concrete Structures: IS:456-2000*. CBS Publishers & Distributors.

SEMESTER – 4

Sr. No.	Course Name	Course No.	Credit	L	P	T
3	Building Construction & Cost	SWCE4.3	2(2+0)	2	0	2

	Estimation				
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Objective

To make the students acquainted with the methods of construction of agricultural buildings and to enable them to prepare various types of estimates of buildings

Theory

Building materials: description of important building materials, rocks, different stones; formation of stones, types of stones, quarrying process, stone products and uses; Bricks, types, preparation and burning of bricks, properties and uses; Tiles, types and classification; Lime, properties and uses, cement, different uses and grades

Concrete: grades, preparation, mixing and laying of concrete, use of sand; Use of ferrous material, iron and steel products; Use of non-ferrous metals, glass, rubber, plastics, aluminum, copper, nickel; Timber and its uses, seasoning, defects, commercial form of timber, miscellaneous building materials

Building construction: building components, foundations, brick work, lintels, columns, roofs and stair cases, different types of floors, plastering and pointing, damp proofing and waterproofing, white washing, distempering and painting, steps for building construction, needs of different agricultural buildings, types and uses, types of roofs, slope and flat roof buildings

Estimating and costing: types of estimates, rough cost, detailed and supplementary estimate, preparation of cost estimate, cost analysis, schedule of rates, analysis of rates, factors affecting building costs, building codes, estate development;

Cost economics: measurement and pricing, economic methods for evaluation of buildings, benefit cost calculation, rate of return period (payback period)

Planning of lectures		
SN	Topics to be covered in lecture	Proposed No. of Lecture
1	Building materials: description of important building materials	1
2	Different stones; formation of stones	1
3	Types of stones & Quarrying process	1
4	Stone products and uses	1
5	Bricks, types, preparation	1
6	Burning of bricks, properties and uses	1
7	Types of tiles	1
8	Classification of Lime and its properties with uses	1
9	Classification of Cement and its different uses with grades	1
10	Concrete: grades, preparation, mixing and laying of concrete,	2
11	Use of sand with classification	1
12	Use of ferrous material, iron and steel products	1
13	Use of non-ferrous metals, glass, rubber, plastics, aluminum, copper, nickel	1
14	Timber and its uses, seasoning, defects, commercial form of timber	1
15	Miscellaneous building materials	2
16	Building construction: building components	2
17	Foundations, brick work, lintels, columns, roofs and stair cases	2
18	Different types of floors	1

19	Plastering and pointing, damp proofing, Waterproofing washing, distempering and painting	1
20	Steps for building construction	1
21	Needs of different agricultural buildings, types and uses	1
22	Types of roofs, slope and flat roof buildings	1
23	Estimating and costing: types of estimates, rough cost, detailed and supplementary estimate	2
24	Preparation of cost estimate, cost analysis, schedule of rates, analysis of rates	2
25	Factors affecting building costs	1
26	Building codes, estate development;	1
27	Cost economics: measurement and pricing	1
28	Economic methods for evaluation of buildings	1
29	Benefit cost calculation	1
30	Rate of return period (payback period)	1
	Total	36

Suggested Reading

1. Punmia B C. Jain A K and Jain A K. 1984. *Building Construction*. Laxmi Publications (P) Ltd., New Delhi.
2. Duggal S K. 2012. *Building material*. New Age International Publishers.
3. Sane Y S. 1964. *Planning and Designing of Buildings*. Engineering Book Publishing Co. Pune.
4. Rangwala S C. 1994. *Engineering Materials*. Charotar Publishing House, Anand. Dutta B N. 2000. *Estimating and Costing*. UBS publishers.

SEMESTER – 4

Sr. No.	Course Name	Course No.	Credit	L	P	T
4	Soil Mechanics	SWCE4.4	2(1+1)	1	1	2

Objective

To make the students acquainted with the principles of soil mechanics and the calculation of different stresses in soil, which will be helpful in designing the retaining walls and other engineering structures

Theory

Introduction to soil mechanics, field and scope of soil mechanics; Phase diagram, physical and index properties of soil, particle size distribution, grain size distribution curve, soil indices; plastic limit, liquid limit, shrinkage limit; Classification of soils, effective and neutral stress, Boussinesq and Westergaard's analysis, Newmark's influence chart, stress distribution and diagrams;

Shear stress, Mohr's circle, direct shear stress, triaxial test and vane shear test; Mohr coulomb failure theory, effective stress principle, determination of shear parameters by direct shear test, triangle test & vane shear test. Numerical exercise based on various types of tests

Compaction of soils, standard and modified proctor test, Abbot's compaction and Jodhpur mini compaction test, field compaction method and control; Consolidation of soils, Terzaghi's theory of one dimensional consolidation, spring analogy, Laboratory consolidation test, calculation of void ratio and coefficient of volume change, Taylor's and Casagrande's method

Earth pressure: plastic equilibrium in soils, active and passive states, Rankine's theory of earth pressure, active and passive earth pressure for cohesive soils, simple numerical exercises; Stability of slopes: introduction to stability analysis of infinite and finite slopes friction circle method, Taylor's stability number, friction circle method

Practical

Determination of moisture content of soil sample; Determination of specific gravity of soil sample; Study of field density by core cutter; Study of bulk density, dry density by sand replacement method; Determination of grain size distribution of coarse grained soil by sieving; Determination of grain size by hydrometer method; Determination of liquid limit by Cassagrande apparatus; Determination of liquid limit by cone penetrometer; Determination of plastic limit of soil specimen; Determination of shrinkage limit of soil; Determination of optimum moisture content of saturated soil by Abbot's compaction test; Determination of optimum moisture content of saturated soil by Proctor's mould; Consolidation characteristics of soil; Shear strength of soil by direct shear test; Shear strength of soil by tri-axial shear test

Planning of lectures		
S.No.	Topics to be covered in Lecture	Proposed No. of Lectures
1	Brief information about syllabus, Introduction to soil mechanics, field and scope of soil mechanics	1
2	Phase diagram, physical and index properties of soil	3
3	Particle size distribution, grain size distribution curve	1
4	Soil indices; plastic limit, liquid limit, shrinkage limit	1
5	Classification of soils	1
6	Effective and neutral stress	1
7	Boussinesq and Westergaard's analysis; Newmark's influence chart, stress distribution and diagrams	1
8	Shear stress, Mohr's circle, direct shear stress, triaxial test and vane shear test; Mohr coulomb failure theory, effective stress principle, determination of shear parameters by direct shear test, triangle test & vane shear test. Numerical exercise based on various types of tests	2
9	Compaction of soils, standard and modified proctor test, Abbot's compaction and Jodhpur mini compaction test, field compaction method and control	1
10	Consolidation of soils, Terzaghi's theory of one dimensional consolidation, spring analogy, Laboratory consolidation test, calculation of void ratio and coefficient of volume change	1
11	Taylor's and Casagrande's method Earth pressure: plastic equilibrium in soils, active and passive states, Rankine's theory of earth pressure, active and passive earth pressure for cohesive soils, simple numerical exercises	2
12	Stability of slopes: introduction to stability analysis of infinite and finite slopes friction circle method, Taylor's stability number, friction circle method	1
	Total	16

Practical

Planning of Practical

S.No.	Topics	Proposed No. of Practical
1	Determination of moisture content of soil sample	2
2	Determination of specific gravity of soil sample	2
3	Study of field density by core cutter	1
4	Study of bulk density, dry density by sand replacement method	1
5	Determination of grain size distribution of coarse grained soil by sieving	1
6	Determination of grain size by hydrometer method	1
7	Determination of liquid limit by Cassagrande apparatus	1
8	Determination of liquid limit by cone penetrometer	1
9	Determination of plastic limit of soil specimen	1
10	Determination of shrinkage limit of soil	1
11	Determination of optimum moisture content of saturated soil by Abbot's compaction test	1
12	Determination of optimum moisture content of saturated soil by Proctor's mould	1
13	Consolidation characteristics of soil	1
14	Shear strength of soil by direct shear test, Shear strength of soil by tri-axial shear test	1
		16

Suggested Reading

1. Punmia B C, Jain A K and Jain A K. 2005. *Soil Mechanics and Foundations*. Laxmi Publications (P) Ltd. New Delhi.
2. Ranjan G and Rao A S R. 1993. *Basic and Applied Soil Mechanics*. Welley Easters Ltd., New Delhi.
3. Singh A. 1994. *Soil Engineering*. Vol. I. CBS Publishers and Distributions, Delhi.

SEMESTER – 4

Sr. No.	Course Name	Course No.	Credit	L	P	T
5	Soil and Water Conservation Engineering	SWCE4.5	3(2+1)	2	1	3

Course Content:

Soil erosion: introduction, causes and types - geological and accelerated erosion, agents, factors affecting and effects of erosion; Water erosion: mechanics and forms- splash, sheet, rill, gully, ravine and stream bank erosion; Gullies: classification, stages of development; Soil loss estimation– Universal soil loss equation (USLE) and modified USLE. Rainfall erosivity-estimation by $KE > 25$ and $EI30$ methods; Soil erodibility topography, crop management and conservation practice factors; Measurement of soil erosion- Runoff plots, soil samples Water erosion control measures- agronomical measures, contour farming, strip cropping, conservation tillage and mulching; Engineering measures- bunds and terraces, bunds: contour and graded bunds design and surplussing arrangements; terraces: level and graded broad base terraces, bench terraces -planning, design and layout procedure, contour stone wall and trenching; Gully and ravine reclamation- principles of gully control, vegetative measures, temporary structures and diversion drains. Grassed waterways and design; Energy and momentum principles in open

channels; specific energy and specific force, hydraulic jump and its application, types of hydraulic jump, energy dissipation due to the jump; Soil erosion control structures- introduction, classification and functional requirements. Permanent structures for soil conservation and gully control- check dams, drop, chute and drop inlet spillways design requirements, planning for design, design procedures- hydrologic, hydraulic and structural design and stability analysis;

Practical

Estimation/measuring techniques of soil loss; Study of rainfall simulator for erosion assessment, estimation of sediment rate using Coshocton wheel sampler and multi-slot devisor; Determination of sediment concentration through oven drying method. Calculation of rate of sedimentation and storage loss in tanks; Study on sedimentation of reservoirs; Design and layout of contour bunds and graded bunds; Design and layout of broad base terraces and bench terraces; Design of vegetative waterways; Design of shelter belts and wind breaks for wind erosion control; Farm pond design, capacity and estimation; Hydraulic design of drop spillway; Determination of uplift force and construction of uplift pressure diagram, structural design and stability analysis of drop spillway; Hydraulic and structural design of chute spillway, design of SAF energy dissipater; Design of drop inlet spillway; Study on components of earth embankments and its design; Design of water harvesting structures; Study on prioritization of watershed; Visit to soil erosion sites and watershed project areas for studying erosion control and water conservation measures; Visit to a watershed

Planning of Lectures		
Sr. No	Topics to be covered in lecture	Proposed No. of Lectures
1.	Soil erosion: introduction, causes and types - geological and accelerated erosion, agents, factors affecting and effects of erosion	1
2.	Water erosion: mechanics and forms- splash, sheet, rill, gully, ravine and stream bank erosion; Gullies: classification, stages of development;	2
3.	Soil loss estimation– Universal soil loss equation (USLE) and modified USLE. Rainfall erosivity-estimation by KE>25 and EI30 methods; Soil erodibility topography, crop management and conservation practice factors. Measurement of soil erosion- Runoff plots, soil samples Water erosion control measures-	4
4.	Agronomical measures, contour farming, strip cropping, conservation tillage and mulching	1
5.	Engineering measures- bunds and terraces, bunds: contour and graded bunds design and surplussing arrangements;	3
6.	Terraces: level and graded broad base terraces, bench terraces -planning, design and layout procedure, contour stone wall and trenching;	3
7.	Gully and ravine reclamation- principles of gully control, vegetative measures, temporary structures and diversion drains.	1
8.	Grassed waterways and design	2
9.	Energy and momentum principles in open channels; specific energy and specific force, hydraulic jump and its application, types of hydraulic jump, energy dissipation due to the jump;	2
10.	Soil erosion control structures- introduction, classification and functional requirements. Permanent structures for soil conservation and gully control-check dams, drop, chute and drop inlet spillways design requirements,	5

	planning for design, design procedures- hydrologic, hydraulic and structural design and stability analysis;	
11.	Wind erosion- factors affecting, mechanics, soil loss estimation and control measures - vegetative, mechanical measures, wind breaks and shelter belts and stabilization of sand dunes;	2
12.	Land capability classification, dryland farming; Rate of sedimentation, silt monitoring and storage loss in tanks, control of sedimentation in reservoirs;	2
13.	Water harvesting techniques- classification based on source, storage and use, runoff harvesting- short term and long-term techniques; Structures- farm ponds - dug-out and embankment reservoir types, tanks and subsurface dykes;	2
14.	Farm pond- components, site selection, design criteria, capacity, embankment, mechanical and emergency spillways, cost estimation and construction; Percolation pond - site selection, design and construction details. Design considerations of <i>nala</i> bunds.	2
Total		32

Planning of Practicals		
Sr. No	Topics to be covered in lecture	No. of Practical
1.	Estimation of soil loss by USLE, computation of rainfall erosivity index, computation of soil erodibility index in soil loss estimation; Determination of length of slope (LS) and cropping practice (CP) factors	1
2.	Estimation/measuring techniques of soil loss; Study of rainfall simulator for erosion assessment, estimation of sediment rate using Coshocton wheel sampler and multi-slot devisor;	1
3.	Determination of sediment concentration through oven drying method.	1
4.	Calculation of rate of sedimentation and storage loss in tanks; Study on sedimentation of reservoirs	1
5.	Design and layout of contour bunds and graded bunds	1
6.	Design and layout of broad base terraces and bench terraces	1
7.	Design of vegetative waterways	1
8.	Design of shelter belts and wind breaks for wind erosion control	1
9.	Farm pond design, capacity and estimation	1
10.	Hydraulic design of drop spillway	1
11.	Determination of uplift force and construction of uplift pressure diagram, structural design and stability analysis of drop spillway	1
12.	Hydraulic and structural design of chute spillway and design of SAF energy dissipater	1
13.	Design of drop inlet spillway	1
14.	Study on components of earth embankments and its design	1
15.	Design of water harvesting structures	1
16.	Study on prioritization of watershed	1
17.	Visit to soil erosion sites and watershed project areas for studying erosion control and water conservation measures; Visit to a watershed	1
Total		17

Suggested Reading

1. Chow V T. 1985. *Open-Channel Hydraulics*. McGraw- Hill Book Company, Inc.
2. Singh G, Venkataraman C, Sastry G and Joshi B P. 1996. *Manual of Soil and Water Conservation Practices*. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
3. Mahnot S C. 2014. *Soil and Water Conservation and Watershed Management*. International Books and Periodicals Supply Service, New Delhi.
4. Mal B C. 2014. *Introduction to Soil and Water Conservation Engineering*. 2014. Kalyani Publishers.
5. Michael A M and Ojha T P. 2003. *Principles of Agricultural Engineering*. Volume II. 4th Edition, Jain Brothers, New Delhi.
6. Murthy V V N. 2002. *Land and Water Management Engineering*. 4th Edition, Kalyani Publishers, New Delhi.
7. Norman Hudson. 1985. *Soil Conservation*. Cornell University Press, Ithaka, New York, USA.
8. Frevert R K, Schwab G O, Edminster T W and Barnes K K. 2009. *Soil and Water Conservation Engineering*, 4th Edition, John Wiley and Sons, New York.
9. Samra J S, Sharda V N and Sikka A K. 2002. *Water Harvesting and Recycling: Indian Experiences*. CSWCR&TI, Dehradun, Allied Printers, Dehradun.
10. Sharda V N, Juyal G P, Prakash C and Joshi B P. 2007. *Training Manual: Soil Conservation & Watershed Management (Vol.-II)* – CSWCRTI Publication, Dehradun.
11. Suresh R. 2014. *Soil and Water Conservation Engineering*. Standard Publisher Distributors, New Delhi.
12. Das G. 2000. *Hydrology and Soil Conservation Engineering*. Prentice Hall of India Pvt. Ltd., New Delhi.
13. USDA. 1964. *Engineering Hand Book on Drop Spillways (Section-11)*. USDA, Soil Conservation Service.

SEMESTER – 4

Sr. No.	Course Name	Course No.	Credit	L	P	T
6	Farm Machinery & Equipment - II	FMPE 4.6	3(2+1)	2	1	3

Objective

To make the students acquainted with the basic construction and operational features, and economics of operation of different farm machineries used in operations such as weeding, harvesting, etc., including operations done by combines, etc.

Theory

Plant protection equipment: Different types of sprayers and dusters; Classification of sprayers and sprays; Types of nozzles; Calculations for calibration of sprayers and chemical application rates; Introduction to interculture equipment; Weeders- different types of manual and powered weeders; Functional requirements of weeders and main components; Different types of fertilizer application methods and equipment.

Harvesting of crops: Harvesting methods, harvesting terminology; Mowers– types, constructional details, working and adjustments; Shear type harvesting devices- cutter bar, inertia forces, counter balancing, terminology, cutting pattern; Reapers, binders and windrowers- principle of operation and constructional details; Hay conditioning, importance, methods of hay conditioning, and calculation of moisture content of hay.

Threshing: manual and mechanical systems; Types of threshing drums and their applications;

Types of threshers- tangential and axial, constructional details and cleaning systems; Factors affecting thresher performance; Grain combines- combine terminology and features, classification of grain combines, study of material flow in combines; Computation of combine losses; Combine troubles and troubleshooting; Chaff cutters- working principle, constructional features and capacity calculations; Straw combines- working principle and constructional details. Root crop diggers: Principles of operation, functional components, blade adjustment and approach angle, calculation of material handled; Potato and groundnut diggers; Cotton harvesting- cotton harvesting mechanisms, cotton pickers and strippers; Maize harvesting combines; Vegetables and fruit harvesting equipment and tools.

Testing and Evaluation of intercultural, plant protection and harvesting machinery and their test codes.

Practical

Familiarization with plant protection and interculture equipment; Study of sprayers- types, functional components, calibration; Study of dusters- types and functional components; Calculations for chemical application rates; Study of nozzle types and spread pattern using patternator; Familiarization with manual and powered weeding equipment and identification of functional components; Study of fertilizer application equipment including manure spreaders and fertilizer broadcasters; Study of various types of mowers, reaper, reaper binder; Study of functional components of mowers and reapers; Study of threshing systems, cleaning systems in threshers, calculations of losses in threshers; Study of functional units of grain combines and their types, calculations for grain losses in a combine; Study of root crop diggers and familiarization with the functional units and attachments; Study of the working of cotton and maize harvesters; Study of different vegetable and fruit harvesters; Testing and evaluation of intercultural, plant protection and harvesting machinery; Visit to field showing operations of various machines; Visit to implement manufacturing unit.

Planning of Lectures		
Sr. No	Topics to be covered in Lectures	No. of Lectures
1	Introduction to plant protection equipment, Different types of sprayers and dusters.	1
2	Classification of sprayers and sprays, Types of nozzles, Calculations for calibration of sprayers and chemical application rates.	2
3	Introduction to interculture equipment, Weeders- different types of manual and powered weeders, Functional requirements of weeders and main components.	2
4	Introduction to different types of fertilizer application methods and equipment.	1
5	Study of harvesting operation of crops, harvesting methods, harvesting terminology.	2
6	Study of mowers– types, constructional details, working and adjustments.	2
7	Study of shear type harvesting devices- cutter bar, inertia forces, counter balancing, terminology, cutting pattern.	2
8	Study of reapers, binders and windrowers- principle of operation and constructional details.	2
9	Introduction to hay conditioning, its importance, methods of hay conditioning and calculation of moisture content of hay.	2
10	Introduction to threshing systems- manual and mechanical systems, Types of threshing drums and their applications.	2
11	Introduction to various types of threshers- tangential and axial, constructional	1

	details and cleaning systems, Study of factors affecting thresher performance.	
12	Study of grain combines- combine terminology and features, classification of grain combines, study of material flow in combines.	2
13	Computation of combine losses, Study of combine troubles and troubleshooting.	2
14	Study of chaff cutters- working principle, constructional features and capacity calculations,	1
15	Study of straw combines- working principle and constructional details.	2
16	Study of root crop diggers- principles of operation, functional components, blade adjustment and approach angle and calculation of material handled, Study of potato and groundnut diggers.	2
17	Study of cotton harvesting- cotton harvesting mechanisms, cotton pickers and strippers.	1
18	Study of maize harvesting combines,	1
19	Introduction to vegetables and fruit harvesting equipment and tools.	1
20	Study of testing and evaluation of intercultural, plant protection and harvesting machinery and their test codes.	1
Total		32

Planning of Practical		
Sr. No	Topics to be covered in Practical	No. of Practical
1	Familiarization with plant protection and interculture equipment.	2
2	Study of sprayers- types and functional components. Study of dusters- types and functional components; Calculations for chemical application rates; Study of nozzle types and spread pattern using patternator.	2
3	Familiarization with manual and powered weeding equipment and identification of functional components.	1
4	Study of fertilizer application equipment including manure spreaders and fertilizer broadcasters.	1
5	Study of various types of mowers, reaper, reaper binder, Study of functional components of mowers and reapers.	1
6	Study of threshing systems, cleaning systems in threshers, calculations of losses in threshers.	1
7	Study of functional units of grain combines and their types, calculations for grain losses in a combine.	2
8	Study of root crop diggers and familiarization with the functional units and attachments.	1
9	Study of the working of cotton and maize harvesters.	1
10	Study of different vegetable and fruit harvesters.	1
11	Testing and evaluation of intercultural, plant protection and harvesting machinery.	1
12	Visit to field showing operations various machines;	1
13	Visit to implement manufacturing unit	1
Total		16

Suggested Readings:

1. Jain, S. C. and Phillips, G. 2003. Farm Machinery - An Approach. Standard Publishers and Distributors.
2. Kepner, R. A., Bainer, R. and Barger, E. L. 2005. Principles of Farm Machinery. CBS Publishers and Distributors.
3. Lal Radhey and Datta, A. C. 1978. Agricultural Engineering through Worked Out Examples. Saroj Prakashan, Allahabad.
4. Nakra, C. P. 2003. Farm Machines and Equipment. Dhanpat Rai and Publishing Co.
5. Smith, H. P. and Wilkes, L. H. 2011. Farm Machinery and Equipment. McGraw Hill Publication, New York.
6. Srivastav, A. K., Goering, C. E. and Rohrbach, R. P. 2005. Engineering Principles of Agricultural Machines. ASAE. St. Joseph, Mich.
7. Srivastava, A. C. 1991. Elements of Farm Machinery. Oxford and IBH Publication.
8. Srivastava, T. K. 2007. A work Book on Practical Farm Machinery. Vol. I and II. Saroj Prakashan, Allahabad.
9. Suresh, R. and Kumar, S. 2018. Farm Power and Machinery Engineering. Standard Publishers.

SEMESTER –4

Sr. No.	Course Name	Course No.	Credit	L	P	T
7	Renewable Energy Sources	REE4.7	3(2+1)	2	1	3

Objective

To make the students acquainted with the different renewable energy sources and to enable them to analyse and select the appropriate technology to meet the energy demand in different types of agricultural operations

Theory

Different sources of renewable energy- concepts and limitations of different renewable energy sources (RES) as solar, wind, geothermal, biomass, ocean energy sources; Criteria for assessing the potential of RES; Comparison of renewable energy sources with non-renewable sources;

Solar energy- energy available from sun, solar radiation data, solar energy conversion into heat through flat plate and concentrating collectors, different solar thermal devices, principle of natural and forced convection solar drying system; Solar photo voltaics- basics and applications, p-n junctions; Solar cells, PV systems, stand alone, grid connected solar power station; Calculation of energy through photovoltaic power generation and cost economics

Wind energy- energy availability, general formula, lift and drag; Basics of wind energy conversion, effect of density, frequency variances, angle of attack, wind speed, types of windmill rotors,

determination of torque coefficient, induction type generators; Working principle of wind power plant; Wind farms, aero-generators, wind power generation system

Biogas- basics of anaerobic digestion, types and constructional details of biogas plants, biogas generation and its properties, factors affecting biogas generation and usages, design considerations, advantages and disadvantages of biogas spent slurry; Generation of power from biogas; Design & use of different commercial biogas plants

Power generation from urban, municipal and industrial waste; Ocean thermal and electric power generation, wave and tidal power; Power generation from biomass (gasification &

Dendro- thermal);Mini and micro hydel plants; Fuel cells and its associated parameters

Practical

Study of solar thermal devices like solar cookers; Study of solar water heating system; Study of natural convection solar dryer; Study of forced convection solar dryer; Study of solar desalination unit; Study of solar greenhouse for agriculture production; Study of cost economics of solar thermal devices including solar panels; Study of solar photovoltaic system and study of characteristics of solar photovoltaic panel; Study of evaluation of solar air heater/dryer; Study of biogas plants and its components; Performance evaluation of a fixed dome type biogas plant; Performance evaluation of floating drum type biogas plant; Study of biomass gasifiers; Study of cost economics of biogas system; Visit to a windmill plant.

Planning of Lectures		
Sr. No	Topics to be covered in lecture	Proposed No. of Lectures
1.	Different sources of renewable energy- concepts and limitations of different renewable energy sources (RES) as solar,	2
2.	wind, geothermal, biomass, ocean energy sources;	2
3.	Criteria for assessing the potential of RES;	2
4.	Comparison of renewable energy sources with non-renewable sources;	2
5.	Solar energy- energy available from sun, solar radiation data, solar energy conversion into heat through flat plate and concentrating collectors, different solar thermal devices	2
6.	Principle of natural and forced convection solar drying system;	2
7.	Solar photo voltaics- basics and applications, p-n junctions; Solar cells, PV systems, stand alone, grid connected solar power station;	2
8.	Calculation of energy through photovoltaic power generation and cost economics	2
9.	Wind energy- energy availability, general formula, lift and drag;	2
10.	Basics of wind energy conversion, effect of density, frequency variances, angle of attack, wind speed, types of windmill rotors	2
11.	determination of torque coefficient, induction type generators	2
12.	Working principle of wind power plant; Wind farms, aero-generators, wind power generation system	2
13.	Biogas- basics of anaerobic digestion, types and constructional details of biogas plants, biogas generation and its properties	2
14.	factors affecting biogas generation and usages, design considerations, advantages and disadvantages of biogas spent slurry;	2
15.	Generation of power from biogas; Design & use of different commercial biogas plants Power generation from urban, municipal and industrial waste;	2
16.	Ocean thermal and electric power generation, wave and tidal power;	2
17.	Power generation from biomass (gasification & Dendro- thermal);Mini and micro hydel plants; Fuel cells and its associated parameters	2
Total		34

Planning of Practicals

Sr. No	Topics to be covered in Practical	No. of Practical
1.	Study of solar thermal devices like solar cookers; Study of solar water heating system; Study of natural convection solar dryer;	3
2.	Study of solar desalination unit; Study of solar greenhouse for agriculture production;	3
3.	Study of cost economics of solar thermal devices including solar panels; Study of solar photovoltaic system and study of characteristics of solar photovoltaic panel;	4
4.	Study of evaluation of solar air heater/dryer; Study of biogas plants and its components; Performance evaluation of a fixed dome type biogas plant;	3
5.	Performance evaluation of floating drum type biogas plant; Study of biomass gasifiers; Study of cost economics of biogas system; Visit to a windmill plant.	4
Total		17

Suggested Reading

1. Basu P. 2018. *Biomass Gasification and Pyrolysis Practical Design and Theory*. Academic Press.
2. Deublein D and Steinhauser A. 2008. *Biogas from Waste and Renewable Resources*. WILEY- VCH Verlag GmbH & Co. KGaA, Weinheim.
3. Duffie J A and Beckman W A. 2013. *Solar Engineering of Thermal Process*. John Wiley and Sons
4. Julian Chen C. 2011. *Physics of Solar Energy*. John Wiley & Sons, Inc.
5. Khan B H. 2006. *Non-Conventional Energy Resources*. The McGraw Hill Publishers.
6. Knothe G, Gerpen J V, Krahl J. (Eds.). 2010. *The Biodiesel Handbook*. AOCS Press.
7. Patel M R. 2005. *Wind and Solar Power Systems*. CRC Press, Boca Racon.
8. Rai G D. 2013. *Non-Conventional Energy Sources*. Khanna Publishers, New Delhi.
9. Rai G D. 2020. *Solar Energy Utilization*. Khanna Publishers, New Delhi.
10. Reed T B and Das A. 1988. *Hand book of Biomass Downdraft Gassifier Engine Systems*. SERI, USA.
11. Ryszard Petela. 2010. *Engineering Thermodynamics of Thermal Radiation for Solar Power Utilization*. The McGraw-Hill Companies.
12. Stefan C W, Krauter. 2008. *Solar Electric Power Generation – Photovoltaic Energy Systems*. Springer.

SEMESTER –4

Sr. No.	Course Name	Course No.	Credit	L	P	T
8	Post-Harvest Engineering of Cereals, Pulses and Oilseeds	PFE-4.8	3(2+1)	2	1	3

Objective

To make the students acquainted with the different unit operations in processing of major cereals, pulses and oilseeds, and the different equipment for the operations

Course content: Theory: General unit operations in agricultural process engineering and importance of these unit operations in grain processing; Structure and composition of cereals, pulses and oil seeds.

Cleaning and grading: Principles of cleaning, scalping, sorting and grading; screens, different types of screen separators, fixed and variable aperture screens, capacity and effectiveness of screens, sieve analysis; various types of separators as specific gravity, magnetic, disc, spiral, pneumatic, inclined belt draper, velvet roll separator, colour sorter, cyclone separator.

Drying: Moisture content and water activity, free moisture, bound moisture and equilibrium moisture content, isotherm, hysteresis effect, EMC determination; Psychrometric chart and its use in drying; Drying principles and theory, thin layer and deep bed drying analysis, falling rate and constant rate drying periods, maximum and decreasing drying rate periods, drying equations, mass and energy balance, Shedd's equation; Drying methods (conduction, convection, radiation, batch, continuous); Different types of grain dryers (bin, flat bed, LSU, columnar, RPEC, fluidized, rotary and tray), tempering during drying; dryer performance.

Principles of grain storage; different types of grain storage structures; deep bin and shallow bin; design of a silo, structural and functional requirements of a grain storage go-down.

Size reduction: Principle; Bond's law, Kick's law, Rittinger's law; Sieve analysis; Different classifications of size reduction machines; description of jaw crusher, hammer mill, attrition mill, and ball mill; Material handling: Basic parts of different types of conveyors and elevators, viz. belt, roller, chain, screw, and bucket elevator, cranes and hoists, pneumatic conveying, power requirement for conveying and elevating.

Milling of rice: Parboiling- merits and demerits, changes during parboiling of rice, parboiling methods, viz. traditional methods, CFTRI method, Jadavpur method, pressure parboiling; different unit operations and equipment involved in traditional and modern rice milling methods; Preparation of rice products as rice flakes and puffed rice.

Milling of wheat: Unit operations and equipment; Milling of corn: unit operations and equipment in dry and wet milling methods; Milling of pulses: pre-conditioning, dry milling and wet milling methods, CFTRI and Pantnagar methods, pulse milling machines; Milling of oilseeds: preconditioning of oilseeds, mechanical expression, screw press, hydraulic press, solvent extraction method, refining of oil, stabilization of rice bran.

Practical:

Study of different types of screens and study of screen effectiveness; Study of construction and operation of different types of cleaners and separators; Measurement of moisture content: dry basis and wet basis; Study on drying characteristics of grains and determination of drying constant; Determination of EMC (static and dynamic method); Study of psychrometric chart; Study of various types of dryers; Study of different size reduction machines; Sieve analysis, determination of fineness modulus and uniformity index; Study of different unit operations and machineries in rice mills; Study of different unit operations and machineries in pulse mills; Study of different unit operations and machineries in oil mills; Study of different unit operations and machineries in wheat/ flour mills; Study of different unit operations and machineries in corn processing units; Study of extrusion process; Study of different types of conveying and elevating equipment.

Planning of lectures		
Sr. No.	Topics to be covered in Lecture	Proposed No. of Lectures
1.	General unit operations in agricultural process engineering and importance of these unit operations in grain processing; Structure and composition of cereals, pulses and oil seeds.	1
2.	Cleaning and grading: Principles of cleaning, scalping, sorting and grading; screens, different types of screen separators, fixed and variable aperture screens, capacity and effectiveness of screens, sieve analysis; various types of separators as specific gravity, magnetic, disc, spiral, pneumatic, inclined belt draper, velvet roll separator, colour sorter, cyclone separator.	4
3.	Drying: Moisture content and water activity, free moisture, bound moisture and equilibrium moisture content, isotherm, hysteresis effect, EMC determination; Psychrometric chart and its use in drying; Drying principles and theory, thin layer and deep bed drying analysis, falling rate and constant rate drying periods, maximum and decreasing drying rate periods, drying equations, mass and energy balance, Shedd's equation; Drying methods (conduction, convection, radiation, batch, continuous); Different types of grain dryers (bin, flat bed, LSU, columnar, RPEC, fluidized, rotary and tray), tempering during drying; dryer performance.	6
4.	Principles of grain storage; different types of grain storage structures; deep bin and shallow bin; design of a silo, structural and functional requirements of a grain storage go-down.	3
5.	Size reduction: Principle; Bond's law, Kick's law, Rittinger's law; Sieve analysis; Different classifications of size reduction machines; description of jaw crusher, hammer mill, attrition mill, and ball mill;	3
6.	Material handling: Basic parts of different types of conveyors and elevators, viz. belt, roller, chain, screw, and bucket elevator, cranes and hoists, pneumatic conveying, power requirement for conveying and elevating.	4
7.	Milling of rice: Parboiling- merits and demerits, changes during parboiling of rice, parboiling methods, viz. traditional methods, CFTRI method, Jadavpur method, pressure parboiling; different unit operations and equipment involved in traditional and modern rice milling methods; Preparation of rice products as rice flakes and puffed rice.	4
8.	Milling of wheat: Unit operations and equipment; Milling of corn: unit operations and equipment in dry and wet milling methods;	2
9.	Milling of pulses: pre-conditioning, dry milling and wet milling methods, CFTRI and Pantnagar methods, pulse milling machines;	2
10.	Milling of oilseeds: preconditioning of oilseeds, mechanical expression, screw press, hydraulic press, solvent extraction method, refining of oil, stabilization of rice bran.	3
Total		32
Sr. No.	Topic	No. of Practicals
1.	Study of different types of screens and study of screen effectiveness;	2

2.	Study of construction and operation of different types of cleaners and separators;	1
3.	Measurement of moisture content: dry basis and wet basis; Study on drying characteristics of grains and determination of drying constant;	2
4.	Determination of EMC (static and dynamic method); Study of psychrometric chart;	1
5.	Study of various types of dryers;	1
6.	Study of different size reduction machines; Sieve analysis, determination of fineness modulus and uniformity index;	2
7.	Study of different unit operations and machineries in rice mills;	1
8.	Study of different unit operations and machineries in pulse mills;	1
9.	Study of different unit operations and machineries in oil mills;	1
10.	Study of different unit operations and machineries in wheat/ flour mills;	1
11.	Study of different unit operations and machineries in corn processing units;	1
12.	Study of extrusion process;	1
13.	Study of different types of conveying and elevating equipment.	1
Total		16

Suggested Readings

1. Chakraverty, A. 1999. Post Harvest Technology of Cereals, Pulses and Oilseeds. Oxford & IBH publishing Co. Ltd, New Delhi.
2. Dash, S. K., Bebartta, J. P. and Kar, A. 2012. Rice Processing and Allied Operations. Kalyani Publishers, New Delhi.
3. Geankoplis, C. J. 2002. Transport Processes and Unit Operations. Prentice Hall of India Pvt. Ltd, New Delhi.
4. Mangaraj, S., Dash, S. K., Swain, S. and Ali, N. 2016. Agricultural Process Engineering. Vol II. Kalyani Publishers, New Delhi.
5. McCabe, W. L., Smith, J. C. and Harriott, P. 1993. Unit Operations of Chemical Engineering. McGraw Hill.
6. Sahay, K. M. and Singh, K. K. 1994. Unit Operations of Agricultural Processing. Vikas Publishing House Pvt. Ltd, New Delhi.
7. Swain, S., Dash, S. K., Mangaraj, S. and Ali, N. 2016. Agricultural Process Engineering. Vol I. Kalyani Publishers, New Delhi.

SEMESTER –4

Sr. No.	Course Name	Course No.	Credit	L	P	T
9	Entrepreneurship Development and Business Management	MDC - II	3(2+1)	2	1	3

Course Content:

Development of entrepreneurship, motivational factors, social factors, environmental factors, characteristics of entrepreneurs, entrepreneurial attributes/competencies. Concept, need for and importance of entrepreneurial development. Evolution of entrepreneurship, objectives of entrepreneurial activities, types of entrepreneurs, functions of entrepreneurs, importance of entrepreneurial development, and process of entrepreneurship development. Environment scanning and opportunity identification need for scanning–spotting of opportunity-scanning of environment– identification of product / service – starting a project; factors influencing sensing

the opportunities. Infrastructure and support systems- good policies, schemes for entrepreneurship development; role of financial institutions, and other agencies in entrepreneurship development. Steps involved in functioning of an enterprise. Selection of the product / services, selection of form of ownership; registration, selection of site, capital sources, acquisition of manufacturing know how, packaging and distribution. Planning of an enterprise, project identification, selection, and formulation of project; project report preparation, Enterprise Management. Production management – product, levels of products, product mix, quality control, cost of production, production controls, Material management. Production management – raw material costing, inventory control. Personal management – manpower planning, labour turn over, wages / salaries. Financial management /accounting – funds, fixed capital and working capital, costing and pricing, long term planning and short-term planning, book keeping, journal, ledger, subsidiary books, annual financial statement, taxation. Marketing management- market, types, marketing assistance, market strategies. Crisis management- raw material, production, leadership, market, finance, natural etc.

Practical

Visit to small scale industries/agro-industries, Interaction with successful entrepreneurs/ agric-entrepreneurs. Visit to financial institutions and support agencies. Preparation of project proposal for funding by different agencies.

Planning of Lectures		
Sr. No	Topics to be covered in lecture	Proposed No. of Lectures
1.	Development of entrepreneurship, motivational factors, social factors, environmental factors, characteristics of entrepreneurs, entrepreneurial attributes/competencies.	2
2.	Concept, need for and importance of entrepreneurial development. Evolution of entrepreneurship,	2
3.	Objectives of entrepreneurial activities, types of entrepreneurs, functions of entrepreneurs	2
4.	Importance of entrepreneurial development, and process of entrepreneurship development.	2
5.	Environment scanning and opportunity identification need for scanning–spotting of opportunity-scanning of environment–identification of product / service – starting a project	3
6.	Factors influencing sensing the opportunities. Infrastructure and support systems- good policies, schemes for entrepreneurship development; role of financial institutions, and other agencies in entrepreneurship development.	3
7.	Steps involved in functioning of an enterprise. Selection of the product / services, selection of form of ownership; registration, selection of site, capital sources, acquisition of manufacturing know how, packaging and distribution	2
8.	Planning of an enterprise, project identification, selection, and formulation of project	2
9.	Project report preparation, Enterprise Management. Production management – product, levels of products, product mix, quality control, cost of production, production controls, Material management.	3
10.	Production management – raw material costing, inventory control.	3

11.	Personal management – manpower planning, labour turn over, wages / salaries.	2
12.	Financial management /accounting – funds, fixed capital and working capital, costing and pricing, long term planning and short-term planning, book keeping, journal, ledger, subsidiary books, annual financial statement, taxation.	3
13.	Marketing management- market, types, marketing assistance, market strategies. Crisis management- raw material, production, leadership, market, finance, natural etc.	3
Total		32

Planning of Practicals		
Sr. No	Topics to be covered in Practical	No. of Practical
1.	Visit to small scale industries/agro-industries	4
2.	Interaction with successful entrepreneurs/ agric- entrepreneurs.	4
3.	Visit to financial institutions and support agencies	4
4.	Preparation of project proposal for funding by different agencies.	4
Total		16

Suggested Readings

- Charantimath P.M., 2009, Entrepreneurship Development and Small Business Enterprises. Pearson Publications, New Delhi.
- Desai V., 2015, Entrepreneurship: Development and Management, Himalaya Publishing House.
- Gupta CB. 2001. Management Theory and Practice. Sultan Chand & Sons.
- Indu Grover. 2008. Handbook on Empowerment and Entrepreneurship. Agrotech Public Academy.
- Khanka SS. 1999. Entrepreneurial Development. S. Chand & Co.
- Mehra P., 2016, Business Communication for Managers. Pearson India, New Delhi.
- Pandey M. and Tewari D., 2010, The Agribusiness Book. IBDC Publishers, Lucknow.
- Singh D. 1995. Effective Managerial Leadership. Deep & Deep Publ.
- Singhal R.K., 2013, Entrepreneurship Development & Management, Katson Books.
- Tripathi PC & Reddy PN. 1991. Principles of Management. Tata McGraw Hill.
- Vasant Desai, 1997. Small Scale Industries and Entrepreneurship. Himalaya Publ. House

SEMESTER – 4

Sr. No.	Course Name	Course No.	Credit	L	P	T
10	National Service Scheme (NSS- IV)/ OR National cadet corps (NCC- IV)	AEC-XI OR AEC-XII	1*(0+1)	0	1	0

FACULTY OF AGRICULTURAL ENGINEERING Undergraduate Course Curriculum				
Sr. No.	Course Number	Course Title	Credit Hours	Total Credit Hours

Third Year				
V semester				
1	SWCE5.1	Strength of Materials	2 (1+1)	25 (15+10)
2	FMPE5.2	Theory of Machines	2 (2+0)	
3	PFE5.3	Thermodynamics and Heat Transfer	3 (3+0)	
4	FMPE5.4	Tractor & Automotive Engines	3 (2+1)	
5	IDE5.5	Irrigation and Drainage Engineering	4 (3+1)	
6	PFE5.6	Food and Dairy Engineering	4 (3+1)	
7	AEC - II	Personality Development	2 (1+1)	
8	CAE5.8	Seminar	1 (0+1)	
9	Int 5.9	In-plant Training/ Research Internship - I	4 (0+4)	

SEMESTER – 5

Sr. No.	Course Name	Course No.	Credit	L	P	T
1	Strength of Materials	SWCE5.1	2(1+1)	1	1	2

Objective

To make the students acquainted with the importance of strength parameters of different materials and the techniques to calculate unknown forces in 2D structures

Theory

Introduction to strength of materials;

Slope and deflection of beams: slope and deflection of beam using integration techniques, moment area theorems, conjugate beam method, problems of slope and deflection;

Theory of columns and struts, problems of column and struts;

Steel connections: analysis of rivet connections, analysis of welded connections; Stability analysis of masonry dam; problems on masonry dam

Statically indeterminate structures- analysis of propped beams, analysis of fixed beams, analysis of continuous beams using superimposition and three-moment equation;

Analysis of beam using moment distribution method and solving problems;

Practical

To determine the quality of check of two different aggregates through impact test; To perform the tensile test of steel specimen - to observe the behavior of materials under load - to calculate the value of e - ultimate stress, permissible stress, percentage elongation etc. And to study its fracture; To prepare mortar specimen of different cement, demolding of the specimen next day for compression and tension test after 2nd and 4th week; To prepare concrete specimen to perform the compression, bending test and to measure elasticity - concrete cylinders, cubes and beams to test after 2nd and 4th week; To perform compression and tension test on mortar specimen prepared 2 weeks before; To perform compression and bending test of the concrete specimen prepared 2 weeks before; To perform compression and tension test on mortar specimen prepared 4 weeks before; To perform compression and bending test of the concrete specimen prepared 4 weeks before; To determine young's modulus of elasticity of beam with the help of deflection produced at center due to loads placed at center and quarter points; To perform Brinell's hardness tests on a given specimen; To study the behavior of materials under torsion and to evaluate various elastic constants; To study load deflection and other physical properties of closely coiled helical spring in tension and compression; To write detail report emphasizing engineering importance of performing tension, compression, bending, torsion, impact and hardness tests on the materials.

Planning of lectures		
SN	Topics to be covered in lecture	Proposed No. of Lecture
1	Introduction to strength of materials	1
2	Slope and deflection of beam using integration techniques	2
3	Moment area theorems	2
4	Problems of slope and deflection;	1
5	Theory of columns and struts	1
6	Problems of column and struts	1
7	Analysis of rivet connections	2
8	Analysis of welded connections	2
9	Stability analysis of masonry dam	1
10	Problems on masonry dam	1

11	Statically indeterminate structures- analysis of propped beams	3
12	Analysis of fixed beams	2
13	Analysis of continuous beams using superimposition and three-moment equation	2
14	Analysis of beam using moment distribution method and solving problems	3
	Total	24

Practical		
Sr.No.	Topic	No. of Practical's
1	To determine the quality of check of two different aggregates through impact test	1
2	To perform the tensile test of steel specimen - to observe the behavior of materials under load - to calculate the value of e - ultimate stress, permissible stress, percentage elongation and to study its fracture	1
3	To prepare mortar specimen of different cement	1
4	Demolding of mortar specimen next day for compression and tension test after 2 nd and 4 th week	1
5	To prepare concrete specimen to perform the compression, bending test and to measure elasticity - concrete cylinders, cubes and beams to test after 2 nd and 4 th week	1
6	To perform compression and tension test on mortar specimen prepared 2 weeks before	1
7	To perform compression and bending test of the concrete specimen prepared 2 weeks before	1
8	To perform compression and tension test on mortar specimen prepared 4 weeks before	1
9	To perform compression and bending test of the concrete specimen prepared 4 weeks before	1
10	To determine young's modulus of elasticity of beam with the help of deflection produced at center due to loads placed at center and quarter points	1
11	To perform Brinell's hardness tests on a given specimen	1
12	To study the behavior of materials under torsion and to evaluate various elastic constants	1
13	To study load deflection and other physical properties of closely coiled helical spring in tension and compression	1
14	To write detail report emphasizing engineering importance of performing tension, compression, bending, torsion, impact and hardness tests on the materials.	1
	Total	14

Suggested Reading

1. Junarkar S B. 2001. *Mechanics of Structures* (Vo-I). Choratar Publishing House, Anand.
2. Khurmi R S. 2006. *Strength of Materials*. S. Chand Publishing, New Delhi.
3. Leheri R S and Leheri R S. 2006. *Strength of Materials*. S.K. Kataria & Sons, New Delhi.
4. Ramamrutham S. and Narayanan R. 2003. *Strengths of Materials*. Dhanpat Rai and Sons, Nai Sarak, New Delhi.
5. Vazirani V N, Ratawani M M and Duggal S K. 2012. *Analysis of Structures*. Khanna Publishers, New Delhi.

SEMESTER – 5

Sr. No.	Course Name	Course No.	Credit	L	P	T
2	Theory of Machines	FMPE 5.2	2(2+0)	2	0	2

Objective

1. To enable the students to analyse the relative motion between various parts of machine and forces which act on them
2. To apply the theories in designing the various parts of the machine

Theory

Simple mechanism: Elements, links, pairs, kinematics chain, and mechanisms; classification of pairs and mechanisms; lower and higher pairs; four bar chain, slider crank chain and their inversions; Velocity mechanism: determination of velocity and acceleration using graphical (instantaneous centres) method.

Types of gears, law of gearing, velocity of sliding between two teeth in mesh; Involute and cycloidal profile for gear teeth; Spur gear, nomenclature; Introduction to helical, spiral, bevel and worm gear; Simple, compound, reverted, and epicyclic trains; determining velocity ratio by tabular method.

Turning moment diagrams, coefficient of fluctuation of speed and energy, weight of flywheel, flywheel applications.

Belt drives: Types of drives, belt materials, length of belt, transmitted power, velocity ratio, belt size for flat and V belts; effect of centrifugal tension, creep and slip on power transmission; chain drives, classification of chain drive, terms used in chain drive.

Types of friction, laws of dry friction; friction of pivots and collars; single disc, multiple disc, and cone clutches, rolling friction; Types of governors, constructional details and analysis of Watt, Porter, Proell governors, effect of friction, controlling force curves. sensitiveness, stability, hunting, iso-chronism, power and effort of a governor.

Static and dynamic balancing, balancing of rotating masses in one and different planes.

Planning of Lectures		
Sr. No	Topics to be covered in Lectures	No. of Lectures
1	Simple mechanism: Elements, links, pairs, kinematics chain, and mechanisms	2
2	Classification of pairs and mechanisms; lower and higher pairs;	2
3	Four bar chain, slider crank chain and their inversions;	2
4	Velocity mechanism: determination of velocity and acceleration using graphical (instantaneous centres) method	4
5	Types of gears, law of gearing, velocity of sliding between two teeth in mesh; Involute and cycloidal profile for gear teeth; Spur gear, nomenclature	2
6	Introduction to helical, spiral, bevel and worm gear;	2
7	Simple, compound, reverted, and epicyclic trains; determining velocity ratio by tabular method	3
8	Turning moment diagrams, coefficient of fluctuation of speed and energy, weight of flywheel, flywheel applications	2
9	Belt drives: Types of drives, belt materials, length of belt, transmitted power, velocity ratio, belt size for flat and V belts; effect of centrifugal tension, creep and slip on power transmission;	3
10	Chain drives, classification of chain drive, terms used in chain drive	2
11	Types of friction, laws of dry friction; friction of pivots and collars; single disc, multiple disc, and cone clutches, rolling friction	2

12	Types of governors, constructional details and analysis of Watt, Porter, Proell governors, effect of friction, controlling force curves. Sensitiveness, stability, hunting, iso-chronism, power and effort of a governor.	4
13	Static and dynamic balancing, balancing of rotating masses in one and different planes.	2
Total		32

Suggested Reading

1. Ballaney, P. L. 2016. A Text Book of Theory of Machines. Khanna Publishers, New Delhi.
2. Bansal, R. K. 2009. A Text Book of Theory of Machines. Laxmi Publications (P) Ltd., New Delhi.
3. Khurmi, R. S. and Gupta, J. K. 2010. A Text Book of Theory of Machines. Euresia Publishing House (P) Ltd, New Delhi.
4. Ratan, S. S. 2010. A Text Book of Theory of Machines. Tata McGraw Hill Publishing Company Ltd, New Delhi.

SEMESTER – 5

Sr. No.	Course Name	Course No.	Credit	L	P	T
3	Thermodynamics and Heat Transfer	PFE 5.3	3(3+0)	3	0	3

Objective

1. To make the students acquainted with principles of thermodynamics and heat transfer
2. To make them understand the mathematical and practical aspects of heat exchangers

Theory

Basic concepts and definitions of thermodynamics, statistical and classical thermodynamics, microscopic and macroscopic point of view; Thermodynamic systems- thermodynamic equilibrium, properties of systems; state, path, process, cycle; point function, path function; temperature and zeroth law of thermodynamics; pressure, specific volume, density, energy, work and heat.

First law of thermodynamics: internal energy, law of conservation of energy, first law of thermodynamics, application of first law to a process; energy-a property of system, perpetual motion machine of the first kind-PMM1; characteristic equation of state, specific heats; application of first law of thermodynamics to non-flow or closed system; free expansion and throttling process; Second law of thermodynamics: limitations of first law of thermodynamics and introduction to second law, statements of second law of thermodynamics; Clausius statement, Kelvin-Planck statement; perpetual motion machine of the second kind-PMM2; Clausius inequality; Carnot Cycle, Carnot's Theorem, entropy, entropy changes for a closed system.

Concept, modes of heat transfer, thermal conductivity of materials, measurement, general differential equation of conduction, one dimensional steady state conduction through plane and composite walls, tubes and spheres without heat generation, electrical analogy, insulation materials and fins; Free and forced convection, Newton's law of cooling, heat transfer coefficient in convection, non-dimensional numbers; equation of laminar boundary layer on flat plate and in a tube, laminar forced convection on a flat plate and tube, combined free and forced convection.

Thermal radiation, black body radiation, Stefan-Boltzman law, black body emissive power, emissivity, absorptivity, reflectivity and transmissivity.

Heat transfer analysis involving conduction, convection and radiation; Types of heat exchangers; fouling, log mean temperature difference, heat exchanger performance, transfer units; Heat exchanger analysis restricted to parallel and counter flow heat exchangers.

Introduction to mass transfer, analogy between heat and mass transfer, Fick's law of diffusion.

Planning of Lectures		
Sr. No	Topics to be covered in Lectures	No. of Lectures
1	Basic concepts and definitions of thermodynamics, statistical and classical thermodynamics, microscopic and macroscopic point of view; Thermodynamic systems-thermodynamic equilibrium,	4
2	Properties of systems; state, path, process, cycle ;point function, path function; temperature and zeroth law of thermodynamics; pressure, specific volume, density, energy, work and heat	4
3	First law of thermodynamics- internal energy, law of conservation of energy, first law of thermodynamics, application of first law to a process; energy-a property of system, perpetual motion machine of the first kind-PMM1.	4
4	Characteristic equation of state, specific heats.	2
5	Application of first law of thermodynamics to non-flow or closed system, free expansion & throttling process.	2
6	Second law of thermodynamics ,Limitations of first law of thermodynamics and introduction to second law, statements of second law of thermodynamics; Clausius statement, Kelvin-Planck statement.	4
7	Perpetual motion machine of the second kind-PMM2; Clausius inequality; Carnot Cycle, Carnot's Theorem, entropy, entropy changes for a closed system	4
8	Concept, modes of heat transfer, thermal conductivity of materials, measurement, general differential equation of conduction.	3
9	One dimensional steady state conduction through plane and composite walls, tubes and spheres without heat generation, electrical analogy, insulation materials and fins; Free and forced convection	5
10	Newton's law of cooling, heat transfer coefficient in convection, non-dimensional numbers; equation of laminar boundary layer on flat plate and in a tube, laminar forced convection on a flat plate and tube, combined free and forced convection.	4
11	Thermal radiation, black body radiation, Stefan-Boltzmann law, black body emissive power, emissivity, absorptivity, reflectivity and transmissivity	3
12	Heat transfer analysis involving conduction, convection and radiation.	2
13	Types of heat exchangers; fouling, log mean temperature difference ,heat exchanger performance, transfer units; Heat exchanger analysis restricted to parallel and counter flow heat exchangers.	3
14	Introduction to mass transfer, analogy between heat and mass transfer, Fick's law of diffusion.	4
Total		48

Suggested Reading

1. Gupta, C. P. and Prakash, R. 2008. Engineering Heat Transfer. Nem Chand and Bros., Roorkee.
2. Holman, J. P. 2018. Heat Transfer. McGraw Hill Book Co., New Delhi.

3. Incropera, F. P. and De Witt, D. P. 2016. Fundamentals of Heat and Mass Transfer. John Wiley and Sons, New York.
4. Kumar, D. S. 2016. Engineering Thermodynamics. S.K. Kataria & Sons, Delhi.
5. Rajput, R. K. 2019. A Text Book of Heat and Mass Transfer. S. Chand & Company Ltd., New Delhi.

SEMESTER – 5

Sr. No.	Course Name	Course No.	Credit	L	P	T
4	Tractor and Automotive Engines	FMPE 5.4	3 (2+1)	2	1	3

Objective

To make the students acquainted with the working principles of different systems of internal combustion engines and tractor

Theory

Sources of farm power: conventional and non-conventional energy sources; Classification of tractors and IC engines. Review of thermodynamic principles of IC (CI and SI) engines and deviation from ideal cycle; General energy equation and heat balance sheet; Derivation of thermal efficiency of Otto cycle, Diesel cycle and Dual cycle; Mechanical, thermal and volumetric efficiencies.

Study of engine components their construction, operating principles and functions; Engine strokes and comparison of 2-stroke and 4-stroke engine cycles and CI and SI engines; Engine valve systems, valve mechanism, valve timing diagram, valve clearance adjustment; Cam profile, valve lift and valve opening area.

Inlet and exhaust systems; Importance of air cleaning system; Types of air cleaners and performance characteristics of various air cleaners; Fuel supply system, types of fuels, properties of fuels, calculation of air-fuel ratio.

Different tests on fuel for SI and CI engines; Detonation and knocking in IC engines; Carburetion system, carburetors and their main functional components; Fuel injection system- injection pump, their types, working principles; Fuel injector nozzles- types and working principles. Engine governing- need of governors, governor types and governor characteristics; Lubrication system- need, types, functional components; Lubricants- physical properties, additives and their application. Engine cooling system- need, cooling methods and main functional components; Need and types of thermostat valves; Additives in the coolant; Radiator efficiency.

Ignition system of SI engines; Electrical system including battery, starting motor, battery charging, cut-out, etc.; Comparison of dynamo and alternator; Basics of engine testing.

Practical

Study of different systems of CI engines; Study of engine parts and functions, working principles, etc.; Study of valve systems construction and adjustments; Determination of physical properties of oil and fuel; Study of air cleaning system; fuel supply system of SI engine; Study of diesel injection system and timing; Study of cooling system, and fan performance, thermostat and radiator performance evaluation; Study of part load efficiencies and governing; Study of lubricating system and adjustments; Study of starting and electrical system; Study of ignition system; Study of tractor engine heat balance and engine performance curves; Study of dynamo; Visit to a nozzle calibration unit; Visit to engine manufacturer/ assembler/ spare parts agency.

Planning of Lectures		
Sr.	Topics to be covered in Lectures	No. of

No		Lectures
1	Sources of farm power: conventional and non-conventional energy sources	2
2	Classification of tractors and IC engines	1
3	Review of thermodynamic principles of IC (CI and SI) engines and deviation from ideal cycle; General energy equation and heat balance sheet	2
4	Derivation of thermal efficiency of Otto cycle, Diesel cycle and Dual cycle; Mechanical, thermal and volumetric efficiencies.	2
5	Study of engine components their construction, operating principles and functions	2
6	Engine strokes and comparison of 2-stroke and 4-stroke engine cycles and CI and SI engines	1
7	Engine valve systems, valve mechanism, valve timing diagram, valve clearance adjustment; Cam profile, valve lift and valve opening area	3
8	Inlet and exhaust systems; Importance of air cleaning system; Types of air cleaners and performance characteristics of various air cleaners	2
9	Fuel supply system, types of fuels, properties of fuels, calculation of air-fuel ratio. Different tests on fuel for SI and CI engines; Detonation and knocking in IC engines; Carburetion system, carburetors and their main functional components; Fuel injection system- injection pump, their types, working principles; Fuel injector nozzles- types and working principles.	4
10	Engine governing- need of governors, governor types and governor characteristics	2
11	Lubrication system- need, types, functional components; Lubricants- physical properties, additives and their application.	3
12	Engine cooling system- need, cooling methods and main functional components; Need and types of thermostat valves; Additives in the coolant; Radiator efficiency.	3
13	Ignition system of SI engines; Electrical system including battery, starting motor, battery charging, cut-out, etc.; Comparison of dynamo and alternator	3
14	Basics of engine testing.	2
	Total	32

Planning of Practical		
Sr. No	Topics to be covered in Practical	No. of Practical
1	Study of different systems of CI engines	1
2	Study of engine parts and functions, working principles, etc.	1
3	Study of valve systems construction and adjustments	1
4	Determination of physical properties of fuel	1
5	Determination of physical properties of oil	1
6	Study of air cleaning system	1
7	Study of fuel supply system of SI engine	1
8	Study of fuel supply system of CI engine (diesel injection system and timing)	1
9	Study of cooling system, fan performance, thermostat and radiator performance evaluation	1
10	Study of part load efficiencies and governing system	1
11	Study of lubricating system and adjustments	1

12	Study of ignition system of SI engine	1
13	Study of electrical starting system (Self start) of tractor	1
14	Study of tractor engine heat balance and engine performance curves	1
15	Visit to a nozzle calibration unit/tractor or engine workshop	1
16	Visit to engine manufacturer/ assembler/ spare parts agency.	1
	Total	16

Suggested Reading

1. Ganesan, V. 1999. Internal Combustion Engines. Mc Graw Hill, New Delhi.
2. Goering, C. E. and Hansen, A. C. 2004. Engine and Tractor Power. ASAE. St Joseph, Michigan.
3. Heitner, J. 2004. Automotive Mechanics: Principles and Practices. CBS Publishers.
4. Liljedahl, J. B., Turnquist, P. K., Smith, D. W. and Hoki, M. 1989. Tractors and Their Power Units. Van Nostrand Reinhold, New York.
5. Mathur, M. L. and Sharma, R. P. 1996. A course in Internal Combustion Engines. Dhanpat Rai and Sons, New Delhi.
6. Rodichev, V. and Rodicheva, G. 1984. Tractors and Automobiles. Mir Publishers, Moscow.
7. Singh, K. 2020. Automobile Engineering. Vol II. Standard Publishers and Distributors.
8. Jain, S. C. & Rai, C. R. 2013. Farm Tractor Maintenance and Repair. Standard Publishers Distributors, Delhi.

SEMESTER – 5

Sr. No.	Course Name	Course No.	Credit	L	P	T
5	Irrigation and Drainage Engineering	IDE5.5	4(3+1)	3	1	4

Objective

To make the students acquainted with the different methods of irrigation depending on the crop water requirement and the different drainage solutions depending on specific situations

Theory

Major and medium irrigation schemes of India, purpose of irrigation, merits and demerits of irrigation, source of irrigation water, present status of development and utilization of different water resources of the country; Measurement of irrigation water: weir, flumes and orifices and other methods

Design and lining of irrigation field channels, on-farm structures for water conveyance, control & distribution; Underground pipe conveyance system: components and design; land grading; Criteria for land leveling, land levelling design methods;

Soil-water-plant relationship: soil properties influencing irrigation management, soil water movement, infiltration, soil water potential, soil moisture characteristics, soil moisture constants, measurement of soil moisture, moisture stress and plant response; Water requirement of crops: concept of evapotranspiration (ET), measurement and estimation of ET, water and irrigation requirement of crops, depth of irrigation, frequency of irrigation, irrigation efficiencies;

Surface methods of water application: border, check basin and furrow irrigation- adaptability, specification and design considerations; Water logging-causes and impacts; Drainage, objectives of drainage, familiarization with the drainage problems of the state, drainage

coefficient;

Surface drainage, types and design; Sub-surface drainage: purpose and benefits, investigations of design parameters, hydraulic conductivity, drainable porosity, water table etc., types and use of subsurface drainage system, interceptor and relief drains. Derivation of Hooghoudt's and Ernst's drain spacing equations; Design of subsurface drainage system, drainage materials, drainage pipes, drain envelope; Layout, construction and installation of drains; Drainage structures, vertical drainage, bio- drainage, tile drains, mole drain;

Salt balance, reclamation of saline and alkaline soils, leaching requirements; Conjunctive use of fresh and saline waters

Practical

Measurement of soil moisture by different instruments; Measurement of irrigation water; Measurement of infiltration characteristics; Determination of bulk density, field capacity and wilting point; Estimation of evapotranspiration and water requirement of crops; Study on scheduling of irrigation of field crops; Study of advance, recession and computation of infiltration opportunity time; infiltration by inflow-outflow method; Study on evaluation of border irrigation method; evaluation of furrow irrigation method; evaluation of check basin irrigation method; Study on *in-situ* measurement of hydraulic conductivity by auger hole method; Study on drainage coefficients determination; Study of piezometer, observation well and measurement of water table; Preparation of iso-bath maps; Design of surface drainage systems; Design and installation of subsurface drainage systems; Determination of various chemical properties of soil and water; Study of tile drainage; cost analysis of surface and sub-surface drainage system; Visit to a waterlogged area and study of a drainage project.

Planning of lectures		
S.No.	Topics to be covered in Lecture	Proposed No. of Lectures
1	Major and medium irrigation schemes of India, purpose of irrigation, merits and demerits of irrigation, source of irrigation water, present status of development and utilization of different water resources of the country	4
2	Measurement of irrigation water: weir, flumes and orifices and other methods	4
3	Design and lining of irrigation field channels, on-farm structures for water conveyance, control & distribution	3
4	Underground pipe conveyance system: components and design	3
5	Land grading; Criteria for land leveling, land levelling design methods	3
6	Soil-water-plant relationship: soil properties influencing irrigation management, soil water movement, infiltration, soil water potential, soil moisture characteristics, soil moisture constants, measurement of soil moisture, moisture stress and plant response	5
7	Water requirement of crops: concept of evapotranspiration (ET), measurement and estimation of ET, water and irrigation requirement of crops, depth of irrigation, frequency of irrigation, irrigation efficiencies	6
8	Surface methods of water application: border, check basin and furrow irrigation- adaptability, specification and design considerations	4
9	Water logging-causes and impacts	1
10	Drainage, objectives of drainage, familiarization with the drainage problems of the state, drainage coefficient	2
11	Sub-surface drainage: purpose and benefits, investigations of design	3

	parameters, hydraulic conductivity, drainable porosity, water table etc., types and use of subsurface drainage system, interceptor and relief drains	
12	Derivation of Hooghoudt's and Ernst's drain spacing equations	1
13	Design of subsurface drainage system, drainage materials, drainage pipes, drain envelope	2
14	Layout, construction and installation of drains	2
15	Drainage structures, vertical drainage, biodrainage, tile drains, mole drain	2
16	Salt balance, reclamation of saline and alkaline soils, leaching requirements	2
17	Conjunctive use of fresh and saline waters	1
		48

Planning of Practical		
S.No.	Topics	Proposed No. of Practical
1	Measurement of soil moisture by different instruments	1
2	Measurement of irrigation water	1
3	Measurement of infiltration characteristics	1
4	Determination of bulk density, field capacity and wilting point	1
5	Estimation of evapotranspiration and water requirement of crops	1
6	Study on scheduling of irrigation of field crops	1
7	Study of advance, recession and computation of infiltration opportunity time, Study on evaluation of border irrigation method, Evaluation of check basin irrigation method	1
8	Infiltration by inflow-outflow method, Evaluation of furrow irrigation method	1
9	Study on in-situ measurement of hydraulic conductivity by auger hole method	1
10	Study on drainage coefficients determination	1
11	Study of piezometer, observation well and measurement of water table, Preparation of iso-bath maps	1
12	Design of surface drainage systems	1
13	Design and installation of subsurface drainage systems	1
14	Determination of various chemical properties of soil and water	1
15	Study of tile drainage; cost analysis of surface and subsurface drainage system	1
	Visit to a waterlogged area and study of a drainage project	1
		16

Suggested Reading

1. Allen R G, Pereira L S, Raes D, Smith M. 1998. *Crop evapotranspiration guidelines for computing crop water requirement*. Irrigation and drainage paper 56, FAO of United Nations, Rome
2. Bhattacharya A K. *Drainage Engineering*. ICAR Publications, New Delhi.
3. Bhattacharya A K and Michael A M. 2013. *Land Drainage, Principles, Methods and Applications*. Vikas Publication House, Noida (UP).

4. Israelsen O W, Hansen V E and Stringham G E. 1980. *Irrigation Principles and Practices*. John Wiley & Sons, Inc. USA.
5. Majumdar D K. 2013. *Irrigation Water Management Principles*. PHI learning Private Limited, New Delhi.
6. Michael A M. 2012. *Irrigation: Theory and Practice*. Vikas Publishing House, New Delhi.
7. Michael A M and Ojha T P. 2014. *Principles of Agricultural Engineering Vol-II*. 5th Edition. Jain Brothers Publication, New Delhi.
8. Murthy V V N. 2013. *Land and water Management Engineering*. Kalyani Publishers, New Delhi.
9. Panigrahi B. 2013. *A Handbook on Irrigation and Drainage*. New India Publishing Agency, New Delhi.
10. Ritzema H P. 1994. *Drainage Principles and Applications*. ILRI Publication 16.

SEMESTER – 5

Sr. No.	Course Name	Course No.	Credit	L	P	T
6	Food and Dairy Engineering	PFE-5.6	4 (3 + 1)	3	1	4

Theory:

Introduction to different unit operations in food processing; Process flow charts for preparation of various food products; Mass and energy balance. Dehydration of foods; dryers for solid foods, construction and operation of direct and indirect type solar dryers, tray dryer, tunnel dryer, vacuum dryer, microwave dryer, freeze dryer, etc.; dryers for liquid foods, construction and operation of drum dryer, spray dryer and vacuum band dryer; Evaporation of food products: principle, different types of evaporators, factors affecting steam economy, multiple effect evaporation, vapour recompression; Thermal processing: thermobacteriology, D value, Z value, reaction quotient, process time, different types of retorts and continuous sterilizers, canning process, aseptic processing. Principles and applications of different non-thermal processing methods as vacuum processing, high pressure processing, PEF processing, Ultrasonication, radiation processing; Principles and applications of novel heating methods, viz. ohmic, infrared and dielectric heating. Mixing: Theory of mixing of solids and pastes, mixing index, mixers for solids, liquid foods and pastes, viz. tumbling mixer, screw mixer, ribbon mixer, liquid mixers, sigma-blade mixer, anchor and gate agitator; Separation processes: principle and equipment for sedimentation of solids in liquid and solids in air; Principle and operation of tubular bowl centrifuge and disc bowl centrifuge; Filtration: principle, construction and working principles of different types of filters as plate and frame filter press, shell and leaf filter, centrifugal filter, rotary drum filter, continuous belt filter; Membrane separation: principle, characteristics and applications of reverse osmosis, nanofiltration, ultra-filtration and macro-filtration; membrane modules; Extrusion cooking: principle, factors affecting extrusion cooking, single and twin screw extruders.

Unit operations in milk processing: Engineering, thermal and chemical properties of milk and milk products; Principles and equipment related to receiving of milk, pasteurization, sterilization, homogenization, cream separation, preparation of butter, cheese, paneer and ice cream.

Filling and packaging: Selection of different types of packaging materials for different types of food products; Equipment for filling and packaging of liquid foods such as gravity filler, filling by metering-FFS system, piston type filler, metering cup filler, filling of pastes, filling of powders; aseptic filling of pouches and bottles. Nanotechnology and its applications in food industry; Basics of food plant design and layout; Plant utilities.

Practical:

The preparation of flow charts for various food processing industries is essential for understanding the sequence of operations involved. This includes studying the components of retort systems and the canning process to ensure effective thermal processing. Different types of evaporators and multiple-effect evaporation systems are analyzed to understand their principles and applications. The study of drum dryers and spray dryers focuses on their operation and a comparison of product qualities. Various mixers for solids and liquids are explored, with an emphasis on determining mixing effectiveness and the mixing index. Settling and sedimentation processes in tanks are investigated, alongside the evaluation of different types of filters and membrane modules, as well as the characteristics of various membranes. The measurement and analysis of milk and milk products' properties form a crucial part of the curriculum, along with an in-depth study of milk processing equipment such as pasteurizers, sterilizers, and homogenizers. The preparation and processing of cream, butter, cheese, paneer, and ice cream are examined, along with the study of packaging materials and filling machines for liquids, powders, and granules. Furthermore, the design and layout of food processing plants are analyzed, complemented by visits to food processing industries and dairy plants to gain practical insights into plant layouts and unit operations.

Planning of lectures		
Sr. No.	Topics to be covered in Lecture	Proposed No. of Lectures
1	Introduction to different unit operations in food processing.	1
2	Process flow charts for preparation of various food products.	2
3	Mass and energy balance.	1
4	Dehydration of foods; dryers for solid foods, construction and operation of direct and indirect type solar dryers, tray dryer, tunnel dryer, vacuum dryer, microwave dryer, freeze dryer, etc.	3
5	Dryers for liquid foods, construction and operation of drum dryer, spray dryer and vacuum band dryer.	3
6	Evaporation of food products: principle, different types of evaporators, factors affecting steam economy, multiple effect evaporation, vapour recompression.	3
7	Thermal processing: thermobacteriology, D value, Z value, reaction quotient, process time, different types of retorts and continuous sterilizers, canning process, aseptic processing.	3
8	Principles and applications of different non-thermal processing methods as vacuum processing, high pressure processing, PEF processing, Ultrasonication, radiation processing.	3
9	Principles and applications of novel heating methods, viz. ohmic, infrared and dielectric heating.	2
10	Mixing: Theory of mixing of solids and pastes, mixing index, mixers for solids, liquid foods and pastes, viz. tumbling mixer, screw mixer, ribbon mixer, liquid mixers, sigma-blade mixer and anchor and gate agitator.	4
11	Separation processes: principle and equipment for sedimentation of solids in liquid and solids in air; Principle and operation of tubular bowl centrifuge and disc bowl centrifuge.	3

12	Filtration: principle, construction and working principles of different types of filters as plate and frame filter press, shell and leaf filter, centrifugal filter, rotary drum filter, continuous belt filter.	3
13	Membrane separation: principle, characteristics and applications of reverse osmosis, nanofiltration, ultra-filtration and macro-filtration; membrane modules.	2
14	Extrusion cooking: principle, factors affecting extrusion cooking, single and twin screw extruders.	2
15	Unit operations in milk processing: Engineering, thermal and chemical properties of milk and milk products; Principles and equipment related to receiving of milk, pasteurization, sterilization, homogenization, and cream separation, preparation of butter, cheese, paneer and ice cream.	4
16	Filling and packaging: Selection of different types of packaging materials for different types of food products; Equipment for filling and packaging of liquid foods such as gravity filler, filling by metering-FFS system, piston type filler, metering cup filler, filling of pastes, filling of powders; aseptic filling of pouches and bottles.	5
17	Nanotechnology and its applications in food industry.	1
18	Basics of food plant design and layout. Plant utilities.	1
Total		46

Practicals		
Sr.No.	Topic	No. of Practical
1	Preparation of flow charts for different food processing industries.	1
2	Study of different parts of retort and canning process.	1
3	Study of different types of evaporators and multiple effect evaporation system.	1
4	Study of drum dryer and spray dryer and comparison of product qualities.	1
5	Study of different types of mixers for solids and liquids.	1
6	Determination of mixing effectiveness and mixing index.	1
7	Study of settling and sedimentation process in a tank.	1
8	Study of different types of filters.	1
9	Study of membrane modules and different types of membranes.	1
10	Study of measurement of different properties of milk and milk products.	1
11	Study of milk pasteurizer, sterilizer and homogenizer.	1
12	Study on preparation of cream and butter.	1
13	Study of preparation of cheese, paneer and ice cream.	1
14	Study of different types of packaging materials.	1
15	Study of different types of filling machines for liquids and powder/granules.	1
16	Study of layout of a food processing plant.	1
17	Visit to food processing industries and dairy plants	1
18	Study the plant layout and unit operations.	1
Total		18

Suggested Readings

1. Ahmed, T. 1997. Dairy Plant Engineering and Management. Kitab Mahal.
2. Dash, S. K., Chandra, P. and Kar, A. 2024. Food Engineering Principles and Practice. CRC Press, Boca Raton, USA
3. McCabe, W. L., Smith, J. C. and Harriott. 1999. Unit Operations of Chemical Engineering. McGraw Hill.
4. Rao, D. G. 2009. Fundamentals of Food Engineering. PHI learning Pvt. Ltd, New Delhi.
5. Singh, R. P. and Heldman, D. R. 1993. Introduction to Food Engineering. Academic Press.
6. Toledo, R. T. 1997. Fundamentals of Food Process Engineering. CBS Publishers

SEMESTER – 5

Sr. No.	Course Name	Course No.	Credit	L	P	T
7	Personality Development	AEC - II	2(1+1)	1	1	2

Course Content:

Personality Definition, Nature of personality, theories of personality and its types . The humanistic approach - Maslow's self-actualization theory, shaping of personality, determinants of personality, Myers-Briggs Typology Indicator, Locus of control and performance, Type A and Type B Behaviours, personality and Organizational Behaviour.

Foundations of individual behavior and factors influencing individual behavior, Models of individual behavior, Perception and attributes and factors affecting perception, Attribution theory and case studies on Perception and Attribution. Learning: Meaning and definition, theories and principles of learning, Learning and organizational behavior, Learning and training, learning feedback. Attitude and values, Intelligence- types of Intelligence, theories of intelligence, measurements of intelligence, factors influencing intelligence, intelligence and Organizational behavior, emotional intelligence. Motivation- theories and principles, Teamwork and group dynamics.

Practical

MBTI personality analysis, Learning Styles and Strategies, Motivational needs, Firo-B, Interpersonal Communication, Teamwork and team building, Group Dynamics, Win-win game, Conflict Management, Leadership styles, Case studies on Personality and Organizational Behavior.

Planning of Lectures		
Sr. No	Topics to be covered in lecture	Proposed No. of Lectures
1.	Personality Definition, Nature of personality, theories of personality and its types	2
2.	The humanistic approach - Maslow's self-actualization theory, shaping of personality, determinants of personality, Myers-Briggs Typology Indicator,	3
3.	Locus of control and performance, Type A and Type B Behaviours, personality and Organizational Behaviour.	3
4.	Foundations of individual behavior and factors influencing individual behavior, Models of individual behavior, Perception and attributes and factors affecting perception, Attribution theory and case studies on Perception and Attribution. Learning	3

5.	Meaning and definition, theories and principles of learning, Learning and organizational behavior, Learning and training, learning feedback	3
6.	Attitude and values, Intelligence- types of Intelligence, theories of intelligence, measurements of intelligence, factors influencing intelligence, intelligence and Organizational behavior, emotional intelligence. Motivation- theories and principles, Teamwork and group dynamics.	3
Total		17

Planning of Practicals		
Sr. No	Topics to be covered in Practical	No. of Practical
1.	MBTI personality analysis	3
2.	Learning Styles and Strategies, Motivational needs, Firo-B, Interpersonal Communication	3
3.	Teamwork and team building	3
4.	Group Dynamics, Win-win game, Conflict Management, Leadership styles,	3
5.	Case studies on Personality and Organizational Behavior.	4
Total		16

Suggested reading

1. Andrews, Sudhir, 1988, How to Succeed at Interviews. 21st (rep.) New Delhi. Tata McGraw-Hill.
2. Heller, Robert, 2002, Effective Leadership. Essential Manager series. Dk Publishing.
3. Hindle, Tim, 2003, Reducing Stress. Essential Manager series. Dk Publishing.
4. Lucas, Stephen, 2001, Art of Public Speaking. New Delhi. Tata - Mc-Graw Hill.
5. Mile, D.J, 2004, Power of Positive Thinking. Delhi. Rohan Book Company.
6. Pravesh Kumar, 2005, All about Self- Motivation. New Delhi. Goodwill Publishing House.
7. Smith, B, 2004, Body Language. Delhi: Rohan Book Company.
8. Shaffer, D. R., 2009, Social and Personality Development (6th Edition). Belmont, CA: Wadsworth

FACULTY OF AGRICULTURAL ENGINEERING
Undergraduate Course Curriculum

Sr. No.	Course Number	Course Title	Credit Hours	Total Credit Hours
Third Year				
VI Semester				
1	FMPE6.1	Tractor Systems & Controls	3 (2+1)	22 (14+8)
2	IDE6.2	Groundwater, Wells and Pumps	3 (2+1)	
3	CSE6.3	Sensors, AI and Robotics in Agriculture	3 (2+1)	
4	PFE6.4	Agricultural Structures & Environment Control	3 (2+1)	
5	REE6.5	Bioenergy Systems: Design and Applications	3 (2+1)	
6	PFE6.6	Refrigeration and Air-conditioning	3 (2+1)	
8	PFE6.7	Post-harvest Engineering of Horticultural Crops	2 (1+1)	
9	REE6.8	Waste Utilization and Management	2 (1+1)	

SEMESTER –6

Sr. No.	Course Name	Course No.	Credit	L	P	T
1	Tractor Systems & Controls	FMPE 6.1	3 (2+1)	2	1	3

Objective

1. To make the students acquainted with different systems in a tractor, such as the transmission, brake, steering and hydraulic systems
2. To understand the ergonomical and safety considerations in tractor

Theory

Transmission system- need of the system in a tractor, types, major functional systems; Clutch- need, types, functional requirements, construction and principle of operation; Single plate, multi-plate, centrifugal and dual clutch systems; Gear box- principle of operation, gear box types, functional requirements, and calculation for speed ratio; Differential system- need, functional components, construction, calculation for speed reduction; Final drive; Brake system- types, principle of operation, construction, calculation for braking torque; Steering system- requirements, steering geometry characteristics, functional components, calculation for turning radius; Ackerman steering; Steering systems in track type tractors; Hydraulic system- principle of operation, types, main functional components, functional requirements. hydraulic system adjustments and ADDC; Tractor power outlets- PTO standards, types and functional requirements.

Traction- traction terminology, theoretical calculation of shear force and rolling resistance of traction device; Wheels and tyres- solid tyres and pneumatic tyres, tyre construction and tyre specifications; Traction aids; Tractor mechanics- forces acting on the tractor, determination of CG of a tractor, importance and determination of moment of inertia of a tractor, tractor static

equilibrium, tractor stability especially at turns; Maximum drawbar pull and its determination; Tractor as a spring-mass system; Ergonomic considerations and operational safety; Tractor testing; Engine test codes.

Practical

Study of basic transmission systems and components; Study of clutch functioning, parts and design problem on clutch system; Study of different types of gear box, calculation of speed ratios, design problems on gear box; Study on differential, final drive and planetary gears; Study of brake systems and some design problems; Study of geometry and adjustments of tractor steering; Study of hydraulic systems in a tractor, hydraulic trainer and design problems; Study of various controls in different makes of tractors in relation to anthropometric measurements; Determination of CG and moment of inertia of a tractor; Study of traction performance of a traction wheel; Study of power transmission system of tractor; Study of hitching system of tractor with various matching implements; Study on safety requirements of tractor during operation; Study of tractor testing; Visit to tractor dealers' outlet/ tractor manufacturers.

Planning of Lectures		
Sr. No	Topics to be covered in Lectures	No. of Lectures
1	Transmission system- need of the system in a tractor, types, major functional systems	1
2	Clutch- need, types, functional requirements, construction and principle of operation; Single plate, multi-plate, centrifugal and dual clutch systems	3
3	Gear box- principle of operation, gear box types, functional requirements, and calculation for speed ratio	2
4	Differential system- need, functional components, construction, calculation for speed reduction; Final drive	2
5	Brake system- types, principle of operation, construction, calculation for braking torque	2
6	Steering system- requirements, steering geometry characteristics, functional components, calculation for turning radius; Ackerman steering; Steering systems in track type tractors	3
7	Hydraulic system- principle of operation, types, main functional components, functional requirements. hydraulic system adjustments and ADDC	3
8	Tractor power outlets- PTO standards, types and functional requirements	1
9	Traction- traction terminology, theoretical calculation of shear force and rolling resistance of traction device	2
10	Wheels and tyres- solid tyres and pneumatic tyres, tyre construction and tyre specifications; Traction aids	2
11	Tractor mechanics- forces acting on the tractor	1
12	Determination of CG of a tractor, importance and determination of moment of inertia of a tractor, tractor static equilibrium, tractor stability especially at turns	2
13	Maximum drawbar pull and its determination; Tractor as a spring-mass system	2
14	Ergonomic considerations and operational safety	3
15	Tractor testing; Tractor and Engine test codes	3
	Total	32

Planning of Practical		
Sr. No	Topics to be covered in Practical	No. of Practical
1	Study of basic transmission systems and components	1
2	Study of clutch functioning, parts and design problem on clutch system	1
3	Study of different types of gear box, calculation of speed ratios, design problems on gear box	1
4	Study on differential system and working of differential lock	1
5	Study of final drive and planetary gears	1
6	Study of brake systems and some design problems	1
7	Study of geometry and adjustments of tractor steering	1
8	Study of hydraulic systems in a tractor, hydraulic trainer and design problems	1
9	Study of various controls in different makes of tractors in relation to anthropometric measurements	1
10	Determination of CG of a tractor	1
11	Determination moment of inertia of a tractor	1
12	Study of traction performance of a traction wheel	1
13	Study of hitching system of tractor with various matching implements	1
14	Study on safety requirements of tractor during operation	1
15	Study of tractor testing	1
16	Visit to tractor dealers' outlet/ tractor manufacturers	1
	Total	16

Suggested Reading

1. Barger, E. L., Liljedahl, J. B. and McKibben, E. C. 1967. Tractor and their Power Units. Wiley Eastern.
2. BIS Test codes for tractor.
3. Giri, N. K. 2013. Automobile Mechanics (SI Units). Khanna Publishers, Delhi.
4. Jain, S. C. and Rai, C. R. 2013. Farm Tractor, Maintenance and Repair. Standard Publisher and Distributers, Delhi.
5. Singh, K. 2020. Automobile Engineering. Standard Publisher and Distributers, Delhi.
6. Srivastav, A. K., Goering, C. E. and Rohrbach, R. P. 2005. Engineering Principles of Agricultural Machines. ASAE. St. Joseph, Michigan.

SEMESTER – 6

Sr. No.	Course Name	Course No.	Credit	L	P	T
2	Groundwater, Wells and Pumps	IDE6.2	3(2+1)	2	1	3

Theory:

Groundwater hydrology and hydrologic cycle, groundwater resources of World and India; Occurrence and movement of ground water, aquifer and its types, aquifer properties, groundwater flow direction, flow in relation to groundwater contours; Classification of wells, fully penetrating tube wells and open wells, familiarization of various types of bore wells, design of open wells; Darcy's law, determination of hydraulic conductivity by laboratory and field

method; Groundwater hydraulics- Dupit's assumptions and Dupit's method, Thiem's method; Well interference; determination of aquifer parameters by different method such as Theis, Jacob and Chow's, Theis recovery method; Design of tube well and gravel pack, sanitary protection of tube wells; Groundwater exploration techniques; methods of drilling of wells: percussion, rotary, reverse rotary; DTH; Development of tube well; Basin wise ground water development, safe yield, factors governing safe yield, computation of safe yield by Hill's method, conjunctive use of ground water; Quality of ground water, groundwater pollution; Artificial groundwater recharge techniques; different direct, indirect and combination of methods; Sea water intrusion, coastal aquifers, sources of saline water intrusion, upcoming of saline water, Ghyben-Herzberg relationship between fresh and saline water; Pumping systems: water lifting devices; Classification of pumps, components of centrifugal pumps, priming, pump selection, installation and troubleshooting, performance curves, effect of speed on capacity, head and power, effect of change of impeller dimensions on performance characteristics; Hydraulic ram, deep well turbine pump and submersible pump

Practical

Verification of Darcy's law; Determination of hydraulic conductivity by laboratory and field methods; Study of piezometer, observation well and measurement of water table; Study of groundwater flow direction, preparation of iso-bath maps and its application in the field; Study of different drilling equipment; Sieve analysis for gravel and well screens design; testing of well screen; Estimation of specific yield and specific retention; Estimation of aquifer parameters by Theis method, Coopers-Jacob method, Chow method and Theis Recovery method; Design of well; Study of well losses and well efficiency; Determination of safe yield by Hill's method; Determination of various parameters on groundwater quality; Study on various types of wells; Estimation of ground water balance; Study of various artificial ground water recharge structures; Study of centrifugal pumps, multistage centrifugal pumps, installation and testing of centrifugal pump; Visit to a drilling site; Visit to a groundwater project and a river lift project.

Planning of Lectures		
Sr. No	Topics to be covered in lecture	Proposed No. of Lectures
1.	Groundwater hydrology and hydrologic cycle, groundwater resources of World and India;	1
2.	Occurrence and movement of ground water, aquifer and its types	1
3.	Aquifer properties, groundwater flow direction in relation to groundwater contours	1
4.	Classification of wells, fully penetrating tube wells and open wells, familiarization of various types of bore wells, design of open wells	3
5.	Darcy's law, determination of hydraulic conductivity by laboratory and field method	1
6.	Groundwater hydraulics- Dupit's assumptions and Dupit's method, Thiem's method; Well interference; determination of aquifer parameters by different method such as Theis, Jacob and Chow's, Theis recovery method;	5
7.	Design of tube well and gravel pack, sanitary protection of tube wells	3
8.	Groundwater exploration techniques	1
9.	methods of drilling of wells: percussion, rotary, reverse rotary; DTH; Development of tube well; Basin wise ground water development, safe yield, factors governing safe yield, computation of safe yield by	2

	Hill's method, conjunctive use of ground water	
10.	Quality of ground water, groundwater pollution	1
11.	Artificial groundwater recharge techniques; different direct, indirect and combination of methods	1
12.	Sea water intrusion, coastal aquifers, sources of saline water intrusion, upcoming of saline water, Ghyben-Herzberg relationship between fresh and saline water	2
13.	Pumping systems: water lifting devices;	1
14.	Classification of pumps, components of centrifugal pumps, priming, pump selection, installation and troubleshooting,	3
15.	performance curves, effect of speed on capacity, head and power, effect of change of impeller dimensions on performance characteristics;	3
16.	Hydraulic ram, deep well turbine pump and submersible pump	3
	Total	32

Planning of Practicals		
Sr. No	Topics to be covered in lecture	No. of Practical
1.	Verification of Darcy's law; Determination of hydraulic conductivity by laboratory and field methods;	1
2.	Study of piezometer, observation well and measurement of water table; Study of groundwater flow direction, preparation of iso-bath maps and its application in the field	2
3.	Study of different drilling equipment	1
4.	Sieve analysis for gravel and well screens design; testing of well screen	1
5.	Estimation of specific yield and specific retention	1
6.	Estimation of aquifer parameters by Theis method, Coopers-Jacob method, Chow method and Theis Recovery method	1
7.	Design of well; Study of well losses and well efficiency	1
8.	Determination of safe yield by Hill's method	1
9.	Determination of various parameters on groundwater quality	1
10.	Study on various types of wells	1
11.	Estimation of ground water balance	1
12.	Study of various artificial ground water recharge structures	1
13.	Study of centrifugal pumps, multistage centrifugal pumps, installation and testing of centrifugal pump	1
14.	Visit to a drilling site	1
15.	Visit to a groundwater project and a river lift project.	1
	Total	16

Suggested Reading

1. Todd D K and Mays L W. 2011. *Ground Water Hydrology*. John Wiley & Sons, New York.
2. Garg S P. 1987. *Groundwater and tube wells*. Oxford & IBH Publishing Co. Ltd., New Delhi.
3. Raghunath H M. 2007. *Ground Water*. New Age Publications, New Delhi.

4. Michael A M, Khepar S D and Sondhi S K. 2008. *Water Well & Pump Engineering*. Tata Mc- Graw Hill.
5. Lal R. 1993. *Irrigation Hydraulics*. Ajiwan Shiksha Sansthan, Allahabad.
6. Nagabhusaniah H S. 2020. *Ground Water in Hydrosphere*. CBS Publishers and Distributors, New Delhi.

SEMESTER – 6

Sr. No.	Course Name	Course No.	Credit	L	P	T
3	Sensors, AI and Robotics in Agriculture	CSE6.3	3 (2+1)	2	1	3

Objectives:

1. To enable students to understand the basics and selection of sensors for different agricultural applications.
2. To introduce applications of artificial intelligence and AI programming techniques.
3. To develop problem-solving skills using search and knowledge representation in AI.
4. To familiarize students with open-source hardware (Arduino & Raspberry Pi), robot programming, control algorithms, and basics of neural networks.

Planning of lectures		
SN	Topics to be covered in lecture	Proposed No. of Lecture
1	<p>Module – I: Sensors Fundamentals</p> <ul style="list-style-type: none"> ▪ Lecture 1: Introduction to Sensors and Transducers <ul style="list-style-type: none"> ○ Topics Covered: Introduction to sensors and transducers, Need for sensors in agriculture, Sensor classification (active vs. passive, analog vs. digital, etc.), Units of measurement in sensors (e.g., voltage, current, resistance, etc.) ▪ Lecture 2: Sensor Characteristics <ul style="list-style-type: none"> ○ Topics Covered: Sensor characteristics: Static and dynamic characteristics, Active and passive sensors, Static characteristics: Sensitivity, accuracy, resolution, linearity, hysteresis, Dynamic characteristics: First-order and second-order sensors ▪ Lecture 3: Sensor Working Principles – Part 1 <ul style="list-style-type: none"> ○ Topics Covered: Photoelectric effect, Photo dielectric effect, Hall effect, Thermoelectric effect ▪ Lecture 4: Sensor Working Principles – Part 2 <ul style="list-style-type: none"> ○ Topics Covered: Piezoresistive effect, Piezoelectric effect, Pyroelectric effect, Magneto-mechanical effect (magnetostriction), Magneto-resistive effect ▪ Lecture 5: Detector Materials and Spectroscopy <ul style="list-style-type: none"> ○ Topics Covered: Basics of detector materials (Silicon diode, InGaAs, etc.) and their characteristics, Fundamentals of visual, NIR, IR, and FTIR spectroscopy, Remote sensing, data acquisition, and analysis ▪ Lecture 6: Sensor Applications – Part 1 <ul style="list-style-type: none"> ○ Topics Covered: Occupancy and motion detectors, Position, 	8

	<p>displacement, and level sensors, Velocity and acceleration sensors, Force, strain, and tactile sensors</p> <ul style="list-style-type: none"> ▪ Lecture 7: Sensor Applications – Part 2 <ul style="list-style-type: none"> ○ Topics Covered: Pressure sensors, temperature sensors, optical sensors, and electromagnetic wave detectors, Capacitance sensors, weather sensors, and imaging sensors, Application of sensors in agriculture (e.g., soil moisture, soil temperature, chlorophyll meter, etc.) ▪ Lecture 8: Biosensors and Sensor Selection <ul style="list-style-type: none"> ○ Topics Covered: Biosensors: General components and biomolecules (enzyme, DNA, antibody), Nanomaterials in biosensors: Quantum dots, Selection of sensors for specific applications 	
2	<p>Module – II: Introduction to Artificial Intelligence</p> <ul style="list-style-type: none"> ▪ Lecture 9: Introduction to Artificial Intelligence <ul style="list-style-type: none"> ○ Topics Covered: Overview of AI: Foundations, scope, and history, Problems and approaches in AI, Intelligent agents: Reactive, deliberative, goal-driven, utility-driven, and learning agents ▪ Lecture 10: AI Programming Techniques <ul style="list-style-type: none"> ○ Topics Covered: AI programming techniques, Classical AI: Concept of expert systems, Conflict resolution in AI systems ▪ Lecture 11: Problem-Solving through Search – Part 1 <ul style="list-style-type: none"> ○ Topics Covered: Forward and backward search, State-space search, Blind search algorithms (e.g., depth-first, breadth-first) ▪ Lecture 12: Problem-Solving through Search – Part 2 <ul style="list-style-type: none"> ○ Topics Covered: Heuristic search algorithms (e.g., A*, greedy search), Problem reduction and decomposition, Alpha-beta pruning and minimax algorithm ▪ Lecture 13: Advanced Search Algorithms <ul style="list-style-type: none"> ○ Topics Covered: Constraint propagation, Neural search, stochastic search, and evolutionary search algorithms, Bidirectional search ▪ Lecture 14: Knowledge Representation and Reasoning – Part 1 <ul style="list-style-type: none"> ○ Topics Covered: Foundations of knowledge representation and reasoning, Representing and reasoning about objects, relations, events, actions, time, and space ▪ Lecture 15: Knowledge Representation and Reasoning – Part 2 <ul style="list-style-type: none"> ○ Topics Covered: Predicate logic, Situation calculus, Description logics ▪ Lecture 16: Reasoning with Defaults and Knowledge <ul style="list-style-type: none"> ○ Topics Covered: Reasoning with defaults, Reasoning about knowledge, Sample applications of reasoning in AI ▪ Lecture 17: Planning in AI <ul style="list-style-type: none"> ○ Topics Covered: Planning as search, Partial order planning, Construction and use of planning graphs ▪ Lecture 18: Applications and Limitations of AI Systems <ul style="list-style-type: none"> ○ Topics Covered: Advantages and limitations of AI systems, Case studies and examples of AI applications, Future trends in AI 	10
3	<p>Module – III: Robotics</p> <ul style="list-style-type: none"> ▪ Lecture 19: Introduction to Robotics <ul style="list-style-type: none"> ○ Topics Covered: Introduction to robotics: Definition and scope, Classification of robots based on geometrical configuration (anatomy), Selection of robots for agricultural applications 	8

	<ul style="list-style-type: none"> ▪ Lecture 20: Hardware for Robots <ul style="list-style-type: none"> ○ Topics Covered: Hardware components of robots: Sensors and actuators, Control systems for robots, System interface and integration in robots ▪ Lecture 21: Communication in Robots <ul style="list-style-type: none"> ○ Topics Covered: Internal and external communication in robots, Fundamentals of microprocessor architecture ▪ Lecture 22: Open Source Hardware and Robot Programming <ul style="list-style-type: none"> ○ Topics Covered: Introduction to open-source hardware (Arduino & Raspberry Pi), Basic programming concepts for robot control ▪ Lecture 23: Controlling Algorithms and Neural Networks <ul style="list-style-type: none"> ○ Topics Covered: Controlling algorithms for robots, Basics of neural networks in robotics ▪ Lecture 24: Feedback Systems and Safety Sensors <ul style="list-style-type: none"> ○ Topics Covered: Feedback systems in robots, Safety sensors and their importance ▪ Lecture 25: Controlled Systems and Manipulators <ul style="list-style-type: none"> ○ Topics Covered: Controlled systems: Serial manipulator and parallel manipulator, Components of industrial robotics ▪ Lecture 26: Dynamic Characteristics of Robots <ul style="list-style-type: none"> ○ Topics Covered: Dynamic characteristics: Speed of motion, load-carrying capacity, and speed of response, Applications of robotics in agriculture 	
4	<p>Module – IV: Applications in Agriculture</p> <ul style="list-style-type: none"> ▪ Lecture 27: Introduction to Precision Farming <ul style="list-style-type: none"> ○ Topics Covered: Introduction to precision farming tools, Implementation of precision agriculture, Site-specific management: Nutrient management, agro-chemicals, and fertilizer management ▪ Lecture 28: Weed Management and Drone Applications <ul style="list-style-type: none"> ○ Topics Covered: Weed management using precision farming techniques, Application of drones: Pesticide/nutrient spraying and environmental monitoring ▪ Lecture 29: Yield Monitoring and Soil Analysis <ul style="list-style-type: none"> ○ Topics Covered: Yield monitoring and mapping, Soil sampling and analysis ▪ Lecture 30: Protected Cultivation and Smart Irrigation <ul style="list-style-type: none"> ○ Topics Covered: Protected cultivation: Smart irrigation systems, Precision livestock farming ▪ Lecture 31: Applications in Food Processing and Image Processing <ul style="list-style-type: none"> ○ Topics Covered: Applications in food processing, Image processing: Shape analysis, feature detection, and object location ▪ Lecture 32: Electronic Nose and Electronic Tongue <ul style="list-style-type: none"> ○ Topics Covered: Gas and chemical sensors for electronic nose and electronic tongue, Case studies and examples of applications in agriculture 	6

Practical

Sr. No.	Topic	No. of Practical's
1	Practical 1: Identification of Various Sensors <ul style="list-style-type: none"> • Tasks: <ul style="list-style-type: none"> ○ Examine different types of sensors. ○ Understand their working principles and applications. 	1
2	Practical 2: Measurement of Displacement, Force, and Pressure <ul style="list-style-type: none"> • Tasks: <ul style="list-style-type: none"> ○ Set up sensors for displacement, force, and pressure measurement. ○ Record and analyze data. 	1
3	Practical 3: Use of Load Sensor on Tractors <ul style="list-style-type: none"> • Tasks: <ul style="list-style-type: none"> ○ Install load sensors on a tractor. ○ Measure and analyze pulling force data. 	1
4	Practical 4: Introduction to Open Source Programming Languages <ul style="list-style-type: none"> • Tasks: <ul style="list-style-type: none"> ○ Overview of popular open-source programming languages (e.g., Python, C++). ○ Discuss pros and cons. 	1
5	Practical 5: Programming in Embedded-C <ul style="list-style-type: none"> • Tasks: <ul style="list-style-type: none"> ○ Write simple programs in Embedded-C. ○ Understand syntax and structure. 	1
6	Practical 6: Identification of Components in Open Source Hardware <ul style="list-style-type: none"> • Tasks: <ul style="list-style-type: none"> ○ Examine Arduino and Raspberry Pi boards. ○ Identify and understand the function of each component. 	1
7	Practical 7: LED Blink Using Open Source Hardware <ul style="list-style-type: none"> • Tasks: <ul style="list-style-type: none"> ○ Write and upload a program to blink an LED. ○ Understand the basic setup of open-source hardware. 	1
8	Practical 8: Buzzer Control Using Open Source Hardware <ul style="list-style-type: none"> • Tasks: <ul style="list-style-type: none"> ○ Write and upload a program to control a buzzer. ○ Understand the interfacing of a buzzer with open-source hardware. 	1
9	Practical 9: Distance Measurement Using Ultrasonic and IR Sensors <ul style="list-style-type: none"> • Tasks: <ul style="list-style-type: none"> ○ Set up ultrasonic and IR sensors. ○ Write programs to measure and display distance. 	1
10	Practical 10: Automatic Irrigation Using Moisture, Temperature, and Humidity Sensors <ul style="list-style-type: none"> • Tasks: <ul style="list-style-type: none"> ○ Set up sensors and control system. ○ Write a program for automatic irrigation based on sensor data. 	1
11	Practical 11: Detection-Based Spraying System Using Ultrasound <ul style="list-style-type: none"> • Tasks: <ul style="list-style-type: none"> ○ Program the system to detect objects and trigger spraying. ○ Test the system with different scenarios. 	1
12	Practical 12: Installation and Testing of Spraying System on Sprayer Unit	1

	<ul style="list-style-type: none"> • Tasks: <ul style="list-style-type: none"> ○ Integrate sensors and actuators with the sprayer. ○ Test the system in a real-world setup. 	
13	Practical 13: Open Source Image Processing Software <ul style="list-style-type: none"> • Tasks: <ul style="list-style-type: none"> ○ Use software like OpenCV for image processing tasks. ○ Perform shape analysis and object detection. 	1
14	Practical 14: Applications of Robots in Agriculture <ul style="list-style-type: none"> • Tasks: <ul style="list-style-type: none"> ○ Study case studies and examples. ○ Discuss potential applications and benefits. 	1
15	Practical 15: Fabrication and Integration of Sensors <ul style="list-style-type: none"> • Tasks: <ul style="list-style-type: none"> ○ Design and assemble a sensor-based system. ○ Integrate sensors with control units. 	1
16	Practical 16: Visit to Robot Fabrication Facilities/Workshop <ul style="list-style-type: none"> • Tasks: <ul style="list-style-type: none"> ○ Observe the fabrication and assembly process. ○ Interact with professionals and understand real-world applications. 	1

Suggested Readings

1. Bräunl T. (2013). *Embedded Robotics Mobile Robot Design and Applications with Embedded Systems*. Springer.
2. Craig John J. (2005). *Introduction to Robotics*. Pearson Education Inc.
3. Ghoshal Asitava. (2006). *Robotics: Fundamental Concepts and Analysis*. Oxford University Press.
4. Gonzalez & Wintz. *Digital Image Processing* (3rd Ed.).
5. Jha S N. (2015). *Rapid Detection of Food Adulterants and Contaminants: Theory and Practice*. Elsevier.
6. Jha S. N. (2010). *Nondestructive Evaluation of Food Quality: Theory and Practice*. Springer.
7. Nikku, S. B. (2020). *Introduction to Robotics – Analysis, Control, Applications* (3rd Ed.). John Wiley & Sons Ltd.
8. Nilsson Nils J. (1980). *Principles of Artificial Intelligence*. Elsevier.
9. Rich, Knight & Nair. *Artificial Intelligence*. Tata McGraw Hill.
10. Saha S K. (2014). *Introduction to Robotics*. Tata McGraw Hills Education.
11. Schilling Robert J. (1990). *Fundamentals of Robotics – Analysis and Control*. Prentice Hall of India.

SEMESTER – 6

Sr. No.	Course Name	Course No.	Credit	L	P	T
4	Agricultural Structures and Environmental Control	PFE-6.4	3 (2+1)	2	1	3

Objective:

1. To make the students acquainted with the different types of agricultural structures
2. To enable them to prepare plan and estimate for different farm structures and environment control measures.

Theory:

Farm and farmstead, farmstead planning and lay out; Environmental control- scope, importance and need, physiological reaction of livestock, environmental control, systems and design, control of temperature, humidity and air ventilation; BIS standards for dairy, piggery and other farm structures. Farm structures- design, construction and cost estimation of farm structures, animal shelters, compost pit, fodder silo, farm fencing, implement shed, barn for cows, buffalo, poultry etc.; Greenhouses- types, poly houses /shed nets, cladding materials, plant environment interactions, design and construction of greenhouses, site selection, orientation, design for ventilation requirement using exhaust fan system, selection of equipment, greenhouse cooling and heating system. Grain storage structures- grain storage methods, moisture and temperature change in grain bins, traditional storage structures and their improvement, improved storage structures (CAP, hermitage storage, Pusa bin, RCC ring bin), design consideration for grain storage go-down, bag storage structure, shallow and deep bins, calculation of pressure in bins; Storage of seeds. Rural housing and development; Farm roads- types of roads in the farm, construction methods, repair and maintenance of rural roads; Water supply and sanitation- sources of water supply for human beings and animals, drinking water standards, water treatment for rural community, site selection and orientation of buildings for sanitation; Sewage system and design, maintenance, septic tank for small family. Rural electrification- estimate of domestic power requirement, sources of power supply, electrification for rural housing.

Practical:

Measurement of environmental parameters, Temp, RH, wind velocity, cooling load; Design and layout of a dairy farm; Design and layout of a poultry house; Design and layout of a goat/sheep house; Design and layout of a farm fencing system; Design and layout of a feed/fodder system; Design and layout of a green house; Design and layout of a grain storage structure; Design and layout of a bag storage structure; Performance of domestic storage structure; Design layout of a threshing floor.

Planning of lectures		
Sr. No.	Topics to be covered in Lecture	Proposed No. of Lectures
1	Farm and farmstead, farmstead planning and lay out.	1
2	Environmental control- scope, importance and need.	1
3	Physiological reaction of livestock.	1
4	Environmental control, systems and design,	1
5	Control of temperature, humidity and air ventilation.	2
6	BIS standards for dairy, piggery and other farm structures. BIS standards for dairy, piggery and other farm structures.	2
7	Design, construction and cost estimation of farm structures; animal shelters, compost pit, fodder silo, fencing and implement sheds, barn for cows, buffalo, poultry, etc	4

8	Greenhouses- types, poly houses/shed nets, cladding materials, plant environment interactions, design and construction of greenhouses. Site selection, orientation, design for ventilation requirement using exhaust fan system, selection of equipment, greenhouse cooling and heating system.	4
9	Grain storage structures- grain storage methods, moisture and temperature change in grain bins, traditional storage structures and their improvement. Improved storage structures (CAP, hermitage storage, Pusa bin, RCC ring bin). Design consideration for grain storage go-down, bag storage structure, shallow and deep bins, calculation of pressure in bins. Storage of seeds.	5
10	Rural housing and development; Farm roads- types of roads in the farm, construction methods, repair and maintenance of rural roads.	2
11	Water supply and sanitation- sources of water supply for human beings and animals, drinking water standards, water treatment for rural community.	2
12	Site selection and orientation of buildings for sanitation. Sewage system and design, maintenance, septic tank for small family.	4
13	Rural electrification- estimate of domestic power requirement, sources of power supply, electrification for rural housing.	3
Total		32

Practical		
Sr. No.	Topic	No. of Practical
1	Measurement of environmental parameters, Temp, RH, wind velocity, cooling load.	2
2	Design and layout of a dairy farm.	1
3	Design and layout of a poultry house.	1
4	Design and layout of a goat/sheep house.	1
5	Design and layout of a farm fencing system.	1
6	Design and layout of a feed/fodder system.	1
7	Design and layout of a green house.	2
8	Design and layout of a grain storage structure.	2
9	Design and layout of a bag storage structure.	2
10	Performance of domestic storage structure.	2
11	Design layout of a threshing floor.	1
Total		16

Suggested Readings:

1. Banerjee, G. C. 2007. A Text Book of Animal Husbandry. Oxford IBH Publishing Co, New Delhi.
2. Dutta, B. N. 2016. Estimating and Costing in Civil Engineering. Dutta & Co, Lucknow.
3. Garg, S. K. 2010. Water Supply Engineering. Khanna Publishers, New Delhi.
4. Khanna, P. N. 1958. Indian Practical Civil Engineer's Hand Book. Engineer's Publishers, New Delhi.
5. Nathanson, J. A. 1996. Basic Environmental Technology. Prentice Hall of India, New Delhi.

6. Ojha, T. P. and Michael, A. M. 1966. Principles of Agricultural Engineering. Vol. I. Jain Brothers, Karol Bag, New Delhi.
7. Pandey, P. H. 2004. Principles and Practices of Agricultural Structures and Environmental Control. Kalyani Publishers, Ludhiana.
8. Rao, P. V. 2012. Text Book of Environmental Engineering. Prentice Hall of India, New Delhi.
9. Sahay, K. M. and Singh, K. K. 2004. Unit Operations of Agricultural Processing. Vikas Publishing Pvt. Ltd, Noida

SEMESTER – 6

Sr. No.	Course Name	Course No.	Credit	L	P	T
5	Bioenergy Systems: Design and Applications	REE 6.5	3(2+1)	2	1	3

Objective

To make the students acquainted with the different biomass sources, and the different thermochemical and biochemical processes for bioenergy and fuel production

Theory

Biomass sources and characteristics; Fermentation processes and its general requirements; Aerobic and anaerobic fermentation processes and their industrial applications; Heat transfer processes in anaerobic digestion systems;

Biomass production- wastelands, classification and their use through energy plantation; Selection of species, methods of field preparation and transplanting; Harvesting of biomass and coppicing characteristics; Biomass preparation techniques for harnessing (size reduction, densification and drying);

Bio-energy- properties of biomass and conversion technologies, pyrolysis of biomass to produce solid, liquid and gaseous fuels; Biomass gasification, types of gasifiers, various types of biomass cook stoves for rural energy needs; Thermo-chemical degradation; History of small gas producer engine system; Chemistry of gasification; Producer gas-type, operating principle; Gasifier fuels, properties, preparation, conditioning of producer gas; Applications, shaft power generation, thermal application and economics; Trans-esterification for biodiesel production and application in CI engines; production process, properties and application of ethanol; Bio-hydrogen production routes; Environmental aspect of bio-energy; Assessment of greenhouse gas mitigation potential; Cost economics of bio-energy systems

Practical

Study of anaerobic fermentation system for industrial application; Study of gasification for industrial process heat; Study of biodiesel production unit; Study of ethanol production unit; Study of biomass densification technique (briquetting, pelletization, and cubing); Study of integral bio energy system for industrial application; Study of bio energy efficiency in industry and commercial buildings; Study of energy efficiency in building, study of Brayton, Striling and Rankine cycles; Study of Biomass gasifiers; Study of biomass improved cook-stoves; Estimation of calorific value of biogas & producer gas; Testing of diesel engine operation using dual fuels and gas alone; Performance evaluation of biomass gasifier engine system (throat less & downdraft); Study on producer gas- types, application, shaft power generation, thermal application

and economics; Study of cost economics of biofuel.

Theory

Planning of Lectures		
Sr. No	Topics to be covered in lecture	Proposed No. of Lectures
1.	Biomass sources and characteristics;	1
2.	Fermentation processes and its general requirements;	1
3.	Aerobic and anaerobic fermentation processes and their industrial applications	1
4.	Heat transfer processes in anaerobic digestion systems;	3
5.	Biomass production- wastelands, classification and their use through energy plantation;	1
6.	Selection of species, methods of field preparation and transplanting;	5
7.	Harvesting of biomass and coppicing characteristics;	3
8.	Biomass preparation techniques for harnessing (size reduction, densification and drying);	1
9.	Bio-energy- properties of biomass and conversion technologies, pyrolysis of biomass to produce solid, liquid and gaseous fuels;	2
10.	Biomass gasification, types of gasifiers, various types of biomass cook stoves for rural energy needs;	1
11.	Thermo-chemical degradation; History of small gas producer engine system; Chemistry of gasification;	1
12.	Producer gas- type, operating principle; Gasifier fuels, properties, preparation, conditioning of producer gas;	2
13.	Applications, shaft power generation, thermal application and economics;	1
14.	Trans-esterification for biodiesel production and application in CI engines;	3
15.	production process, properties and application of ethanol; Bio-hydrogen production routes;	3
16.	Environmental aspect of bio-energy; Assessment of greenhouse gas mitigation potential;	3
17.	Cost economics of bio-energy systems	
Total		34

Practical

Planning of Practicals		
Sr. No	Topics to be covered in lecture	No. of Practical
1.	Study of anaerobic fermentation system for industrial application;	1
2.	Study of gasification for industrial process heat; Study of biodiesel production unit;	1
3.	Study of ethanol production unit;	1
4.	Study of biomass densification technique (briquetting, pelletization, and cubing);	2
5.	Study of integral bio energy system for industrial application;	1
6.	Study of bio energy efficiency in industry and commercial buildings	1

7.	Study of energy efficiency in building, study of Brayton, Striling and Rankine cycles;	2
8.	Study of Biomass gasifiers;	1
9.	Study of biomass improved cook-stoves;	1
10.	Estimation of calorific value of biogas & producer gas;	1
11.	Testing of diesel engine operation using dual fuels and gas alone	1
12.	Performance evaluation of biomass gasifier engine system (throat less & downdraft);	2
13.	Study on producer gas- types, application, shaft power generation, thermal application and economics;	1
14.	Study of cost economics of biofuel.	1
Total		17

Suggested Reading

1. Basu P. 2018. *Biomass Gasification, Pyrolysis and Torrefaction*. Academic Press.
2. Butler S. 2005. *Renewable Energy Academy: Training wood energy professionals*.
3. Knothe G, Gerpen J V, Krahl J. (Eds.). 2010. *The Biodiesel Handbook*. AOCS Press.
4. Rai G D. 2013. *Non-Conventional Energy Sources*. Khanna Publishers, New Delhi.
5. Reed T B and Das A. 1988. *Hand book of Biomass Downdraft Gasifier Engine Systems*. SERI.

SEMESTER – 6

Sr. No.	Course Name	Course No.	Credit	L	P	T
6	Refrigeration and Air Conditioning	PFE 6.6	3 (2+1)	2	1	3

Objective

1. To make the students acquainted with the principles of refrigeration, different types of refrigerating equipment
2. To enable them to design the refrigeration and air conditioning systems

Theory

Definition of pure substance, phases of a pure substance, phase change process of a pure substances; compressed liquid and saturated liquid, saturated vapour and superheated vapour, saturated temperature and saturated pressure; T-V diagram for heating of water at constant pressure.

Latent heat: Latent heat of fusion, latent heat of vaporization; liquid vapour saturation curve; property diagram for phase change process, T-V diagram, P-V diagram, P-T diagram; property tables, state-liquid and vapour states, saturated liquid-vapour mixture, superheated vapour, compressed liquid.

Principles of refrigeration, units, terminology, production of low temperatures, air refrigerators working on reverse Carnot cycle and Bell Coleman cycle; Vapour refrigeration-mechanism, P-V, T-S, P-h diagrams, vapour compression cycles, dry and wet compression, super cooling and sub cooling; Vapour absorption refrigeration system.

Common refrigerants and their properties; Thermodynamic properties of moist air, perfect gas relationship for approximate calculation, adiabatic saturation process, wet bulb temperature and its measurement, psychrometric chart and its use, elementary psychrometric processes.

Air conditioning: principles, type and functions of air conditioning, physiological principles in air conditioning, air distribution, factors considered for designing an air conditioning system;

Room ratio line, sensible heat factor, by-pass factor; types of air conditioners and their applications; Cold storage plants; calculation of refrigeration load and cold storage design considerations.

Practical

Study of P-V and T-S chart in refrigeration; Study P-h chart (or) Mollier diagram in refrigeration; Solving problems on air refrigeration cycle; Solving problems on vapour compression refrigeration cycle; Study of domestic water cooler; Study of domestic household refrigerator; Study of vapour absorption refrigeration system; Study of cooling tower and to find its efficiency; Study of heat pump test rig; Study of Ice plant test rig; Study of psychrometric chart and various psychrometric processes; Solving problems on psychrometrics; Study of window air conditioner; Study cold storage for fruit and vegetables, freezing load and time calculations for food materials; Study on repair and maintenance of refrigeration and air-conditioning systems; Visit to chilling or ice making and cold storage plants.

Planning of Lectures		
Sr. No	Topics to be covered in Lectures	No. of Lectures
1	Definition of pure substance, phases of a pure substance, phase change process of a pure substances; compressed liquid & saturated liquid, saturated vapour and superheated vapour, saturated temperature & saturated pressure; T-V diagram for heating of water at constant pressure	2
2	Latent heat: latent heat of fusion, latent heat of vaporization; liquid vapour saturation curve; property diagram for phase change process, T-V diagram, P-V diagram, P-T diagram.	2
3	Property tables, state- liquid & vapour states, saturated liquid-vapour mixture, superheated vapour, compressed liquid	1
4	Principles of refrigeration, units, terminology, production of low temperatures	1
5	Air refrigerators working on reverse Carnot cycle and Bell Coleman cycle	3
6	Vapour refrigeration-mechanism, P-V, T- S,P-h diagrams,vapour compression cycles, dry and wet compression, super cooling and sub cooling	4
7	Vapour absorption refrigeration system	2
8	Common refrigerants and their properties	2
9	Thermodynamic properties of moist air, perfect gas relationship for approximate calculation, adiabatic saturation process, wet bulb temperature and its measurement, psychrometric chart and its use.	2
10	Elementary psychrometric processes	3
11	Air conditioning: principles, type and functions of air conditioning, physiological principles in air conditioning.	1
12	Air distribution, factors considered for designing an air-conditioning system; Room ratio line, sensible heat factor, by-pass factor	4
13	Types of air conditioners and their applications	2
14	Cold storage plants; calculation of refrigeration load and cold storage design considerations	3
Total		32

Planning of Practical		
Sr. No	Topics to be covered in Practical	No. of Practical
1	Study of P-V and T-S chart in refrigeration	1
2	Study P-h chart (or) Mollier diagram in refrigeration	1
3	Solving problems on air refrigeration cycle	1
4	Solving problems on vapour compression refrigeration cycle	1
5	Study of domestic water cooler	1
6	Study of domestic household refrigerator	1
7	Study of vapour absorption refrigeration system	1
8	Study of cooling tower and to find its efficiency	1
9	Study of heat pump test rig	1
10	Study of Ice plant test rig	1
11	Study of psychometric chart and various psychometric processes	1
12	Solving problems on psychometrics	1
13	Study of window air conditioner	1
14	Study cold storage for fruit and vegetables, freezing load and time calculations for food materials	1
15	Study on repair and maintenance of refrigeration and air-conditioning systems	1
16	Visit to chilling or ice making and cold storage plants	1
Total		16

Suggested Reading

1. Arora, C.P. 2012. Refrigeration and Air Conditioning. Tata-McGraw-Hill, New Delhi.
2. Khurmi, R. S. 2016. Refrigeration and Air Conditioning. S Chand and Co. Ltd., Ram Nagar, New Delhi.

SEMESTER – 6

Sr. No.	Course Name	Course No.	Credit	L	P	T
7.	Post-harvest Engineering of Horticultural Crops	PFE-6.7	2(1+1)	1	1	2

Objective

To make the students acquainted with unit operations in processing of major horticultural crops and working principles of different machineries for these.

Theory:

Importance of processing of fruits and vegetables, spices, condiments; characteristics and properties of horticultural crops important for processing; General methods of preservation of fruits and vegetables and their relative advantages and disadvantages; Flowcharts for preparation of different finished products.

Sorting and grading methods specific to fruits and vegetables, shape and size sorting, weight sorting, image processing, colour sorting, sorting effectiveness; Peeling: different peeling methods and devices (manual, mechanical, chemical and thermal peeling).

Minimal processing and pack house activities; Size reduction and juice extraction: equipment for slicing, shredding, crushing, chopping, juice extraction; Blanching: importance and objectives; effects on food (nutrition, colour, pigment, texture); blanching methods and equipment.

Drying: Dryers for fruits and vegetables, osmo-dehydration, foam mat drying; advanced drying techniques; quality deterioration during drying of fruits and vegetables; Canning of fruits and vegetables: methods and equipment, types of cans, failures of cans; Chilling and freezing: Chilling requirements of different fruits and vegetables; Freezing of food, freezing time calculations, slow and fast freezing; Equipment for chilling and freezing (mechanical and cryogenic); Cold chain logistics and reefer containers; Cold storage heat load calculations and selection of matching equipment; Design of cold stores.

Post-harvest management and equipment for spices; Post-harvest management and equipment for flowers; Packaging and storage: packaging requirements (for containment, protection and other purposes); Characteristics of different packaging materials used for raw and processed fruits and vegetables products; bulk and retail packages; Modified atmosphere packaging, smart packaging; Packaging machines; Shrink packaging; Storage methods as low temperature storage, evaporatively cooled storage and controlled atmospheric storage.

Practical:

Preparation of different processed horticultural products; Study of fruit graders; Study of different types of peelers and slicers; Study of juicer and pulper; Study of minimal processing of vegetables; Study of blanching equipment, testing the adequacy of blanching; Study of different dryers for fruits and vegetables; Study of foam mat drying and osmotic dehydration processes; Study of different activities in pack house; Cold storage heat load calculations and design; Study of different types of packaging materials; Study of CAS and MAP of vegetables; Study of shrink packaging of foods; Study of hammer mill, pulveriser for grinding of spices to powder; Visit to fruit and vegetable processing/ spice processing plant.

Planning of lectures		
Sr. No.	Topics to be covered in Lecture	Proposed No. of Lectures
1.	Importance of processing of fruits and vegetables, spices, condiments; characteristics and properties of horticultural crops important for processing;	1
2.	General methods of preservation of fruits and vegetables and their relative advantages and disadvantages; Flowcharts for preparation of different finished products.	2
3.	Sorting and grading methods specific to fruits and vegetables, shape and size sorting, weight sorting, image processing, colour sorting, sorting effectiveness; Peeling: different peeling methods and devices (manual, mechanical, chemical and thermal peeling).	2
4.	Minimal processing and pack house activities; Size reduction and juice extraction: equipment for slicing, shredding, crushing, chopping, juice extraction;	1
5.	Blanching: importance and objectives; effects on food (nutrition, colour, pigment, texture); blanching methods and equipment.	1
6.	Drying: Dryers for fruits and vegetables, osmo-dehydration, foam mat	2

	drying; advanced drying techniques; quality deterioration during drying of fruits and vegetables; Canning of fruits and vegetables: methods and equipment, types of cans, failures of cans;	
7.	Chilling and freezing: Chilling requirements of different fruits and vegetables; Freezing of food, freezing time calculations, slow and fast freezing; Equipment for chilling and freezing (mechanical and cryogenic); Cold chain logistics and reefer containers; Cold storage heat load calculations and selection of matching equipment; Design of cold stores.	3
8.	Post-harvest management and equipment for spices; Post-harvest management and equipment for flowers;	1
9.	Packaging and storage: packaging requirements (for containment, protection and other purposes); Characteristics of different packaging materials used for raw and processed fruits and vegetables products; bulk and retail packages; Modified atmosphere packaging, smart packaging; Packaging machines; Shrink packaging;	2
10.	Storage methods as low temperature storage, evaporatively cooled storage and controlled atmospheric storage.	1
Total		16

Sr. No.	Topic	No. of Practicals
1.	Preparation of different processed horticultural products;	1
2.	Study of fruit graders;	1
3.	Study of different types of peelers and slicers;	1
4.	Study of juicer and pulper;	1
5.	Study of minimal processing of vegetables;	1
6.	Study of blanching equipment, testing the adequacy of blanching;	1
7.	Study of different dryers for fruits and vegetables;	1
8.	Study of foam mat drying and osmotic dehydration processes;	2
9.	Study of different activities in pack house;	1
10.	Cold storage heat load calculations and design;	1
11.	Study of different types of packaging materials;	1
12.	Study of CAS and MAP of vegetables;	1
13.	Study of shrink packaging of foods;	1
14.	Study of hammer mill, pulveriser for grinding of spices to powder;	1
15.	Visit to fruit and vegetable processing/ spice processing plant.	1
Total		16

Suggested Readings

1. Dash, S. K., Chandra, P. and Kar, A. 2024. Food Engineering Principles and Practice. CRC Press, Boca Raton, USA
2. Fellows, P. J. 2008. Food Processing Technology Principles and Practices. Woodhead Publishing.
3. Lal, G., Siddappa, G. S. and Tondon, G. L. 2009. Preservation of Fruits and Vegetables. ICAR, New Delhi.

4. Mangaraj, S., Ali, N., Swain, S. and Dash, S. K. 2016. Agricultural Process Engineering Vol. III. Kalyani Publishers, New Delhi
5. Pandey, P. H. 1997. Post-harvest Technology of Fruits and Vegetables (Principles and practices). Saroj Prakashan, Allahabad.
6. Srivastava, R. P. and Kumar, S. 2019. Fruit and Vegetable Preservation: Principles and Practices. Kalyani Publishers, New Delhi.
7. Sudheer, K. P. and Indira, V. 2007. Post-Harvest Engineering of Horticultural Crops. New India Publishing House.

SEMESTER – 6

Sr. No.	Course Name	Course No.	Credit	L	P	T
8	Waste Utilization and Management	REE 6.8	2(1+1)	1	1	2

Course objectives

1. To enable students to understand the concept of Waste to Energy.
2. To link legal, technical and management principles for the production of energy from waste.
3. To learn about the best available technologies for waste to energy.
4. To analyze case studies to understand success and failures.
5. To facilitate the students in developing skills in the decision-making process.

Learning outcomes:

1. On successful completion of this course the students will be able to:
2. Apply the knowledge about the operations of Waste to Energy Plants.
3. Analyze the various aspects of Waste to waste-to-energy management Systems.
4. Carry out Techno-economic feasibility for Waste to waste-to-energy plants.
5. Apply the knowledge in planning and operations of Waste to Energy plants.

Unit Description

The Principles of Waste Management and Waste Utilization. Waste Management Hierarchy and 3R Principle of Reduce, Reuse and Recycle. Waste as a Resource and Alternate Energy source. Waste Sources & Characterization

Waste production in different sectors such as domestic, industrial, agriculture, postconsumer, waste etc. Classification of waste – agro-based, forest residues, domestic waste, industrial waste (hazardous and non-hazardous). Characterization of waste for energy utilization. Waste Selection Criteria.

Technologies for Waste to Energy, Energy production from organic waste through anaerobic digestion and fermentation.

Thermo-chemical Conversion – Combustion, Incineration and heat recovery, Pyrolysis, Gasification; Plasma Arc Technology and other newer technologies. Energy from Plastic Wastes – Non-recyclable plastic wastes for energy recovery. Energy Recovery from wastes and optimization of its use, benchmarking and standardization.

Energy Analysis Waste To Energy & Environmental Implications, Environmental standards for Waste to Energy Plant operations and gas clean-up. Savings on non-renewable fuel resources. Carbon Credits: Carbon foot calculations and carbon credits transfer mechanisms. Centralized and Decentralized Waste to Energy Plants Waste activities – collection, segregation, transportation and storage requirements.

Location and Siting of ‘Waste to Energy’ plants. Industry Specific Applications – In-house use – sugar, distillery, pharmaceuticals, Pulp and paper, refinery and petrochemical industry and any other industry.

Centralized and Decentralized Energy production, distribution and use. Comparison of Centralized and decentralized systems and their operations.

Planning of Lectures		
Sr. No	Topics to be covered in lecture	Proposed No. of Lectures
1.	The Principles of Waste Management and Waste Utilization.	1
2.	Waste Management Hierarchy and 3R Principle of Reduce, Reuse and Recycle. Waste as a Resource and Alternate Energy source	1
3.	Waste Sources & Characterization	1
4.	Waste production in different sectors such as domestic, industrial, agriculture, postconsumer, waste etc.	1
5.	Classification of waste – agro-based, forest residues, domestic waste, industrial waste (hazardous and non-hazardous).	1
6.	Characterization of waste for energy utilization. Waste Selection Criteria.	1
7.	Technologies for Waste to Energy, Energy production from organic waste through anaerobic digestion and fermentation.	2
8.	Thermo-chemical Conversion – Combustion, Incineration and heat recovery, Pyrolysis, Gasification; Plasma Arc Technology and other newer technologies..	1
9.	Energy from Plastic Wastes – Non-recyclable plastic wastes for energy recovery. Energy Recovery from wastes and optimization of its use, benchmarking and standardization	1
10.	Energy Analysis Waste To Energy & Environmental Implications, Environmental standards for Waste to Energy Plant operations and gas clean-up..	2
11.	Savings on non-renewable fuel resources. Carbon Credits: Carbon foot calculations and carbon credits transfer mechanisms	1
12.	Centralized and Decentralized Waste to Energy Plants Waste activities – collection, segregation, transportation and storage requirements.	1
13.	Location and Siting of ‘Waste to Energy’ plants. Industry Specific Applications – In-house use – sugar, distillery, pharmaceuticals, Pulp and paper, refinery and petrochemical industry and any other industry.	2
14.	Centralized and Decentralized Energy production, distribution and use. Comparison of Centralized and decentralized systems and their operations.	1
Total		17

Planning of Practicals		
Sr. No	Topics to be covered in lecture	No. of Practical
1.	The Principles of Waste Management and Waste Utilization.	1
2.	Waste Management Hierarchy and 3R Principle of Reduce, Reuse and Recycle. Waste as a Resource and Alternate Energy source	1
3.	Waste Sources & Characterization	1
4.	Waste production in different sectors such as domestic, industrial, agriculture, postconsumer, waste etc.	1
5.	Classification of waste – agro-based, forest residues, domestic waste, industrial waste (hazardous and non-hazardous).	1
6.	Characterization of waste for energy utilization. Waste Selection Criteria.	1
7.	Technologies for Waste to Energy, Energy production from organic waste through anaerobic digestion and fermentation.	2
8.	Thermo-chemical Conversion – Combustion, Incineration and heat recovery, Pyrolysis, Gasification; Plasma Arc Technology and other newer technologies..	1
9.	Energy from Plastic Wastes – Non-recyclable plastic wastes for energy recovery. Energy Recovery from wastes and optimization of its use, benchmarking and standardization	1
10.	Energy Analysis Waste To Energy & Environmental Implications, Environmental standards for Waste to Energy Plant operations and gas clean-up..	2
11.	Savings on non-renewable fuel resources. Carbon Credits: Carbon foot calculations and carbon credits transfer mechanisms	1
12.	Centralized and Decentralized Waste to Energy Plants Waste activities – collection, segregation, transportation and storage requirements.	1
13.	Location and Siting of ‘Waste to Energy’ plants. Industry Specific Applications – In-house use – sugar, distillery, pharmaceuticals, Pulp and paper, refinery and petrochemical industry and any other industry.	2
14.	Centralized and Decentralized Energy production, distribution and use. Comparison of Centralized and decentralized systems and their operations.	1
Total		17

Text Books

- Priya Bajaj Waste Generation and Utilization, Discovery Publishing House Private Limited New Delhi
- B Tabassum, Priya Bajaj Pawan Kumar Waste Management and Environmental Health
- DISCOVERY PUBLISHING HOUSE New Delhi
- Abu Zahrim Yaser, Husnul A T Asha E-Waste Management Processing And Valorisation Springer Publication New Delhi
- DR Siva Kumaran Principles of Waste Management Techniques: A complete review on waste management techniques Kindle Edition

Reference Books

1. Industrial and Urban Waste Management in India, TERI Press.
2. Wealth from Waste: Trends and Technologies by Banwari Lal and Patwardhan, TERI Press.
3. Fundamentals of waste and Environmental Engineering, S.N Mukhopadhyay, TERI Press.
4. Gazette Notification on Waste Management Rules 2016. CPCB Guidelines for Co-processing in the Cement/Power/Steel Industry

FACULTY OF AGRICULTURAL ENGINEERING				
Undergraduate Course Curriculum				
Sr. No.	Course Number	Course Title	Credit Hours	Total Credit Hours
Fourth Year				
VII semester				
1	SEC7.1	Project- I	3 (0+3)	24 (10+14)
2	FMPE7.2	Engineering Graphics and Design	2 (0+2)	
3	PFE7.3	Food Quality and Safety	3 (2+1)	
4	SWCE7.4	Watershed Planning and Management	3 (2+1)	
5	IDE7.5	Sprinkler & Micro Irrigation Systems	2 (1+1)	
6	FMPE7.6	Machine Design	2 (2+0)	
7	REE7.7	Electrical Machines	3 (2+1)	
8	AS7.8	Agricultural Statistics and Data Analysis	2 (1+1)	
9	Int7.9	In-plant Training/ Research Internship - II	4 (0+4)	
10	ST7.10	Study Tour	2(0+2)* NG	

SEMESTER –7

Sr. No.	Course Name	Course No.	Credit	L	P	T
2	Engineering Graphics and Design	FMPE 7.2	2 (0+2)	0	2	2

Objective

1. To acquaint the students with CAD softwares for drawing of machine components
2. To integrate the computers at various levels of planning and manufacturing

Practical

Application of computers for design; CAD- introduction, overview of CAD window; Various options on drawing screen; Practice on draw and dimension tool bar; Practice on OSNAP, line thickness and format tool bar; Practice on mirror, offset; Practice on array commands; Practice on trim, extend; Practice on trim chamfer and fillet commands; Practice on copy, move, scale and rotate commands; Drawing of 2 D- drawing using draw tool bar; Practice on creating boundary, region, hatch and gradient commands; Practice on Editing polyline- PEDIT and Explode commands; Setting of view ports for sketched drawings; Printing of selected view ports in various paper sizes; 2D- drawing of machine parts with all dimensions and allowances; Drawing of hexagonal, nut and bolt and other machine parts; Practice on 3-D commands.

Planning of Practical		
Sr. No	Topics to be covered in Practical	No. of Practical
1	Application of computers for design; CAD- introduction, overview of CAD window; Various options on drawing screen	1
2	Practice on draw and dimension toolbar	1
3	Practice on OSNAP, line thickness and format tool bar	1
4	Practice on mirror, offset	1
5	Practice on array commands	1
6	Practice on trim, extend	1
7	Practice on trim chamfer and fillet commands	1
8	Practice on copy, move, scale and rotate commands; Drawing of 2D-drawing using draw toolbar	1
9	Practice on creating boundary, region, hatch and gradient commands;	2
10	Practice on Editing polyline- PEDIT and Explode commands	3
11	Setting of view ports for sketched drawings; Printing of selected view ports in various paper sizes.	3
12	2D- drawing of machine parts	3
13	2D- drawing with all dimensions and allowances	3
14	Drawing of hexagonal nut.	2
15	Drawing of hexagonal bolt.	2
16	Drawing of machine parts	2
17	Practice on 3-Dcommands	4
Total		32

Suggested Reading

1. Lee, K. 1999. Principles of CAD/CAM/CAE Systems. Addison Wesley Longman, Inc.

2. Rao, P. N. 2002. CAD/CAM Principles and Applications. McGraw-Hill Education Pvt. Ltd., New Delhi.
3. Sareen, K. and Grewal, C. D. 2010. CAD/CAM Theory and Practice. S. Chand & Company Ltd., New Delhi.
4. Zeid, I. 2011. Mastering CAD/CAM with Engineering. McGraw-Hill Education Pvt. Ltd., New Delhi.

SEMESTER –7

Sr. No.	Course Name	Course No.	Credit	L	P	T
3	Food Quality and Safety	PFE-7.3	3(2+1)	2	1	3

Objective

To enable the student to know about the concept and aim of food quality and safety, food quality characteristics – physical, chemical and biological properties, different hazards and their prevention, different methods for measuring food quality as well as the food safety management system

Course content: Theory:

Basics of food quality, safety and food analysis; Concept, objectives and need of food quality; definition, objective measurement of quality and quality and safety indices.

Quality control, quality control tools, statistical quality control; Sampling (Chemical and Microbiological): purpose, sampling techniques, sampling procedures for liquid, powdered and granular materials; Instrumental method for testing food quality, measurement of colour, flavour, consistency, viscosity, texture and their relationship with food quality and composition.

Non-destructive methods for evaluation of food quality. NIR, FTIR and chemometrics theory and application in food quality prediction. Theory and application of X-ray, CT, MRI, Ultrasound for internal quality inspection of fruits and vegetables. Sorting grading using external image analysis, internal biochemical analysis using spectroscopy.

Sensory evaluation methods, panel selection methods, Interpretation of sensory results.

Food hazards and food safety, Food borne infections, contaminants (physical, chemical, biological), adulteration, food safety strategies- Food Safety Management Systems, GAP, GHP, GMP, TQM, TQC; Hazards and HACCP, Sanitation in food industry (SSOP); Food Laws and Regulations, BIS, AGMARK, FSSAI; International Food standards (ISO-22000, CAC); Food Recall, Traceability; Bio safety and Bioterrorism; Sanitation in food industry.

Practical:

Study of statistical process control in food processing industry; Study of sampling techniques, tools and protocols used in different types of from food handling, processing and marketing establishments; Study of registration process and licensing procedure under FSSAI; Examination of cereals, oilseeds and pulses from go-downs and market shops in relation to specifications provided by standardization techniques; Detection of adulteration and examination of ghee for various standards of Agmark/ FSSAI; Detection of adulteration and examination of spices for

Agmark/ FSSAI standards; Detection of adulteration and examination of milk and milk products for FSSAI standards; Detection of adulteration in fruit products such as jam, jelly, marmalades as per FSSAI specification; Visit to a professional quality control laboratory; Visit to food processing laboratory in an industry and study of records and reports maintained by food processing laboratory.

Planning of lectures		
Sr. No.	Topics to be covered in Lecture	Proposed No. of Lectures
1.	Basics of food quality, safety and food analysis; Concept, objectives and need of food quality; definition, objective measurement of quality and quality and safety indices.	3
2.	Quality control, quality control tools, statistical quality control; Sampling (Chemical and Microbiological): purpose, sampling techniques, sampling procedures for liquid, powdered and granular materials;	4
3.	Instrumental method for testing food quality, measurement of colour, flavour, consistency, viscosity, texture and their relationship with food quality and composition.	4
4.	Non-destructive methods for evaluation of food quality. NIR, FTIR and chemometrics theory and application in food quality prediction.	4
5.	Theory and application of X-ray, CT, MRI, Ultrasound for internal quality inspection of fruits and vegetables. Sorting grading using external image analysis, internal biochemical analysis using spectroscopy.	3
6.	Sensory evaluation methods, panel selection methods, Interpretation of sensory results.	3
7.	Food hazards and food safety, Food borne infections, contaminants (physical, chemical, biological), adulteration, food safety strategies- Food Safety Management Systems, GAP, GHP, GMP, TQM, TQC;	4
8.	Hazards and HACCP, Sanitation in food industry (SSOP); Food Laws and Regulations, BIS, AGMARK, FSSAI; International Food standards (ISO-22000, CAC);	4
9.	Food Recall, Traceability; Bio safety and Bioterrorism; Sanitation in food industry.	3
Total		32

Sr. No.	Topic	No. of Practicals
1.	Study of statistical process control in food processing industry;	1
2.	Study of sampling techniques, tools and protocols used in different types of from food handling, processing and marketing establishments;	1
3.	Study of registration process and licensing procedure under FSSAI;	1
4.	Examination of cereals, oilseeds and pulses from go-downs and market shops in relation to specifications provided by standardization techniques;	3
5.	Detection of adulteration and examination of ghee for various standards of Agmark/ FSSAI;	2
6.	Detection of adulteration and examination of spices for Agmark/ FSSAI	2

	standards;	
7.	Detection of adulteration and examination of milk and milk products for FSSAI standards;	1
8.	Detection of adulteration in fruit products such as jam, jelly, marmalades as per FSSAI specification;	3
9.	Visit to a professional quality control laboratory;	1
10.	Visit to food processing laboratory in an industry and study of records and reports maintained by food processing laboratory.	1
Total		16

Suggested Readings

1. Acharya, K. T. 2017. Everyday Indian Processed foods. National Book Trust.
2. Gupta, V. (Ed.). 2006. The Food Safety and Standards Act along with Rules & Regulations. Commercial Law Publishers (India) Pvt. Ltd.
3. Jha, S. N. 2015. Rapid Detection of Food Adulterants and Contaminants: Theory and Practice. Elsevier, USA (ISBN 9780124200845), p266.
4. Jha, S. N. (Ed.). 2010. Nondestructive Evaluation of Food Quality: Theory and Practice. Springer-Verlag GmbH Berlin Heidelberg, Germany, ISBN 978-3-642-15795-0, doi 10.1007/978-3-642-15796-7: 288p.
5. Mudambi, S. R., Rao, S. M. and Rajgopal, M. V. 2006. Food Science. New Age International Publishers.
6. Negi, H. P. S., Sharma, S. and Sekhon, K. S. 2007. Hand book of Cereal Technology. Kalyani Publishers, New Delhi.
7. Potter, N. N. and Hotchikss, J. H. 1995. Food Science. Chapman and Hall Pub.
8. Raj, D., Sharma, R. and Joshi, V. K. 2011. Quality for Value Addition in Food Processing. New India Publishing Agency, New Delhi
9. Ranganna, S. 1986. Hand book of Analysis and Quality Control for Fruit and Vegetable Products. Tata McGraw-Hill Education.
10. Sharma, A. 2017. A Textbook of Food Science and Technology. CBS Publishers & Distributors.
11. Srivastava, R. P. and Kumar, S. 2017. Fruit and Vegetable Preservation: Principles and Practices. International Book Distributing Company.

Websites and weblinks:

1. <https://www.fssai.gov.in/cms/food-safety-and-standards-regulations.php>
2. <https://www.fssai.gov.in/cms/food-recall.php>
3. <https://www.fao.org/fao-who-codexalimentarius/en/>

SEMESTER -7

Sr. No.	Course Name	Course No.	Credit	L	P	T
4	Watershed Planning and Management	SWCE7.4	3(2+1)	2	1	3

Theory:

Watershed- introduction and characteristics; Watershed management- concept, objectives, factors affecting watershed planning based on land capability classes, hydrologic data for

watershed planning, watershed codification, delineation and prioritization of watersheds – sediment yield index Community mobilization and participatory institution building; participatory watershed management, role of watershed associations, user groups and self-help groups; Participatory Rural Appraisal, understanding gender in relation to agriculture Water budgeting in a watershed; Management measures - rainwater conservation technologies *in-situ* and *ex-situ* storage, water harvesting and recycling; Dry farming techniques - inter-terrace and inter bund land management; Integrated watershed management- concept, components, arable lands - agriculture and horticulture, non-arable lands- forestry, fishery and animal husbandry; Effect of cropping systems, land management and cultural practices on watershed hydrology; Use of remote sensing thematic maps and GIS in watershed planning; Watershed programme-execution, follow-up practices, maintenance, monitoring and evaluation; Planning and formulation of project proposal for watershed management programme including costbenefit analysis; Financial management and accounting procedure

Practical

Delineation of watersheds using toposheets; Surveying and preparation of watershed map; Quantitative analysis of watershed characteristics and parameters; Investigations on watershed for planning and development including PRA; Analysis of hydrologic data for planning watershed management; Measurement of discharge and sediment in a watershed; Water budgeting of watersheds; Study of thematic maps using remote sensing; Study of watershed action plan using GIS; Prioritization of watersheds based on sediment yield index; Study of functional requirement of watershed development structures; Study on components of earth embankments and its design; Study of watershed management technologies; Study of role of various functionaries in watershed development programmes; Study of accounting and financial management systems in watershed entities; Visit to watershed development project areas.

Planning of Lectures		
Sr. No	Topics to be covered in lecture	Proposed No. of Lectures
1.	Watershed- introduction and characteristics	1
2.	Watershed management- concept, objectives, factors affecting watershed planning based on land capability classes,	3
3.	Hydrologic data for watershed planning, watershed codification, delineation and prioritization of watersheds –	3
4.	Sediment yield index Community mobilization and participatory institution building.	2
5.	Participatory watershed management, role of watershed associations, user groups and self-help groups	2
6.	Participatory Rural Appraisal, understanding gender in relation to agriculture Water budgeting in a watershed	3
7.	Management measures - rainwater conservation technologies <i>in-situ</i> and <i>ex-situ</i> storage, water harvesting and recycling	2
8.	Dry farming techniques - inter-terrace and inter bund land management	2
9.	Integrated watershed management- concept, components, arable lands - agriculture and horticulture, non-arable lands- forestry, fishery and animal husbandry	2
10.	Effect of cropping systems, land management and cultural practices on watershed hydrology	2

11.	Use of remote sensing thematic maps and GIS in watershed planning	3
12.	Watershed programme- execution, follow-up practices, maintenance, monitoring and evaluation	2
13.	Planning and formulation of project proposal for watershed management programme including costbenefit analysis	3
14.	Financial management and accounting procedure	2
Total		32

Planning of Practical		
Sr. No	Topics to be covered in lecture	No. of Practical
1.	Delineation of watersheds using toposheets	1
2.	Surveying and preparation of watershed map	1
3.	Quantitative analysis of watershed characteristics and parameters	1
4.	Investigations on watershed for planning and development including PRA	1
5.	Analysis of hydrologic data for planning watershed management	1
6.	Measurement of discharge and sediment in a watershed	1
7.	Water budgeting of watersheds	1
8.	Study of thematic maps using remote sensing	1
9.	Study of watershed action plan using GIS	1
10.	Prioritization of watersheds based on sediment yield index	1
11.	Study of functional requirement of watershed development structures	1
12.	Study on components of earth embankments and its design	1
13.	Study of watershed management technologies	1
14.	Study of role of various functionaries in watershed development programmes	1
15.	Study of accounting and financial management systems in watershed entities	1
16.	Visit to watershed development project areas	1
Total		16

Suggested Reading

1. Das G. 2008. *Hydrology and Soil Conservation Engineering: Including Watershed Management*. 2nd Edition, Prentice-Hall of India Learning Pvt. Ltd., New Delhi.
2. Katyal J C, Singh R P, Sharma S, Das S K, Padmanabhan M V and Mishra P K. 1995. *Field Manual on Watershed Management*. CRIDA, Hyderabad.
3. Mahnot S C. 2014. *Soil and Water Conservation and Watershed Management*. International Books and Periodicals Supply Service. New Delhi.
4. Rajora, R. 2019. *Integrated Watershed Management*. Rawat Publications, New Delhi.
5. Sharda V N, Sikka A K and Juyal G P. 2006. *Participatory Integrated Watershed Management:*
 1. *A Field Manual*. Central Soil and Water Conservation Research and Training Institute, Dehradun.
 6. Singh G D and Poonia T C. 2003. *Fundamentals of Watershed Management Technology*. Yash Publishing House, Bikaner.

7. Thomas C G. 2010. *Land Husbandry and Watershed Management*. Kalyani Publishers, Ludhiana.

SEMESTER – 7

Sr. No.	Course Name	Course No.	Credit	L	P	T
5	Sprinkler & Micro Irrigation Systems	IDE7.5	2(1+1)	1	1	2

Objective

To make the students acquainted with the importance of micro irrigation systems, their design and lay out for efficient water, fertilizer and pesticides applications.

Theory

Sprinkler irrigation: adaptability, problems and prospects, types of sprinkler irrigation systems; Design of sprinkler irrigation system: layout selection, hydraulic design of lateral, sub-main and main pipe line, design steps; Selection of pump and power unit for sprinkler irrigation system; Performance evaluation of sprinkler irrigation system: water distribution pattern and overlapping of sprinklers and laterals, uniformity coefficient and pattern efficiency;

Micro Irrigation systems: types- drip, spray, & bubbler systems, merits and demerits, different components; Design of drip irrigation system: general considerations, wetting patterns, irrigation requirement, emitter selection; Hydraulics of drip irrigation system, design steps; Necessary steps for proper operation of a drip irrigation system, maintenance of micro irrigation system: clogging problems, filter cleaning, flushing and chemical treatment;

Fertigation: advantages and limitations of fertigation, fertigation frequency, duration and injection rate, methods of fertigation

Practical

Study of different components of sprinkler irrigation system; Study of wetting pattern of a sprinkler and requirement for overlapping of sprinkler; Study of discharge and uniformity coefficient; Design and installation of sprinkler irrigation system; Study of cost economics of sprinkler irrigation system; Study on maintenance of sprinkler irrigation system; Field visit to a sprinkler irrigation project; Study of different components of drip irrigation; Design and installation of drip irrigation system; Determination of pressure discharge relationship and emission uniformity for given emitter; Study of different types of filters and determination of filtration efficiency; Study of fertigation, types of liquid fertilisers, determination of rate of injection and calibration for chemigation/ fertigation; Design of irrigation and fertigation schedule for crops; Study on removal of clogging of emitters; Study on maintenance of drip irrigation system; Study of cost economics of drip irrigation system; Field visit to micro irrigation system and evaluation of drip system; Field visit to study foggers.

Planning of lectures		
S.No.	Topics to be covered in Lecture	Proposed No. of Lectures
1	Sprinkler irrigation: adaptability, problems and prospects, types of sprinkler irrigation systems	1
2	Design of sprinkler irrigation system: layout selection, hydraulic design of lateral, sub-main and main pipe line, design steps; Selection of pump and power unit for sprinkler irrigation system	3
3	Performance evaluation of sprinkler irrigation system: water distribution pattern and overlapping of sprinklers and laterals, uniformity coefficient	2

	and pattern efficiency	
4	Micro Irrigation systems: types- drip, spray, & bubbler systems, merits and demerits, different components	2
5	Design of drip irrigation system: general considerations, wetting patterns, irrigation requirement, emitter selection; Hydraulics of drip irrigation system, design steps	3
6	Necessary steps for proper operation of a drip irrigation system, maintenance of micro irrigation system: clogging problems, filter cleaning, flushing and chemical treatment	2
7	Fertigation: advantages and limitations of fertigation, fertigation frequency, duration and injection rate, methods of fertigation	3
8		16

Practical

Planning of Practical		
S.No.	Topics	Proposed No. of Practical
1	Study of different components of sprinkler irrigation system	1
2	Design and installation of sprinkler irrigation system	1
3	Study of cost economics of sprinkler irrigation system	1
4	Study on maintenance of sprinkler irrigation system	1
5	Study of wetting pattern of a sprinkler and requirement for overlapping of sprinkler, Study of discharge and uniformity coefficient	1
6	Field visit to a sprinkler irrigation project	1
7	Study of different components of drip irrigation	1
8	Design and installation of drip irrigation system	1
9	Study of cost economics of drip irrigation system	1
10	Study on maintenance of drip irrigation system	1
11	Determination of pressure discharge relationship and emission uniformity for given emitter	1
12	Field visit to micro irrigation system and evaluation of drip system, Field visit to study foggers	1
13	Study of different types of filters and determination of filtration efficiency	1
14	Study of fertigation, types of liquid fertilisers	1
15	Determination of rate of injection and calibration for chemigation/fertigation	1
16	Design of irrigation and fertigation schedule for crops; Study on removal of clogging of emitters	1
		16

Suggested Reading

1. Jain S C and Philip G. 2003. Farm Machinery - An Approach. Standard Publishers and Distributors, Delhi.
2. Mane M S and Ayare B L. 2007. Principles of Sprinkler Irrigation system. Jain Brothers, New Delhi.
3. Mane M S and Ayare B L and Magar S S. 2006. Principles of Drip Irrigation systems. Jain Brothers, New Delhi.

4. Michael A M, Shrimohan and Swaminathan K R. 1972. Design and evaluation of irrigation methods (IARI Monograph No.1). Water Technology Center, IARI New Delhi.
5. Michael A M. 2012. Irrigation: Theory and Practice. Vikas Publishing, New Delhi.
6. Sivanappan R K. 1992. Sprinkler Irrigation. Oxford & IBH Publishing House, New Delhi.
7. Suresh R. 2010. Micro Irrigation - Theory and Practices. Standard Publishers Distributors, Delhi.

SEMESTER – 7

Sr. No.	Course Name	Course No.	Credit	L	P	T
6	Machine Design	FMPE 7.6	2 (2+0)	2	0	2

Objective

To make the students acquainted with design considerations for various machine components so as to enable them to take up the work of new design.

Theory

Phases of design, design considerations; Common engineering materials and their mechanical properties; Types of loads and stresses, theories of failure, factor of safety, selection of allowable stress, stress concentration, elementary fatigue and creep aspects; Design of shafts under torsion and combined bending and torsion; Design of keys; Design of muff, sleeve, and rigid flange couplings; Cotter joints, design of socket and spigot cotter joint; knuckle joint; Design of welded subjected to static loads; Design of helical and leaf springs; Design of threaded fasteners subjected to direct static loads, bolted joints loaded in shear and bolted joints subjected to eccentric loading; Design of flat belt and V-belt drives and pulleys; Design of gears.

Planning of Lectures		
Sr. No	Topics to be covered in Lectures	No. of Lectures
1	Phases of design, design considerations;	1
2	Common engineering materials and their mechanical properties;	2
3	Types of loads and stresses,	1
4	Theories of failure, factor of safety, selection of allowable stress	2
5	stress concentration, elementary fatigue and creep aspects;	2
6	Design of shafts under torsion and combined bending and torsion	3
7	Design of keys; Design of muff, sleeve, and rigid flange couplings	3
8	Cotter joints, design of socket and spigot cotter joint; knuckle joint	4
9	Design of welded subjected to static loads;	2
10	Design of helical and leaf springs	3
11	Design of threaded fasteners subjected to direct static loads, bolted joints loaded in shear and bolted joints subjected to eccentric loading	3
12	Design of flat belt drives and pulleys	2
13	Design of V-belt drives and pulleys	2
14	Design of gears	2
Total		32

Suggested Reading

1. Bhandari, V. B. 2007. Introduction to Machine Design. Tata Mc. Graw Hill Publishing House. New Delhi.

2. Jain, R. K. 2013. Machine Design. Khanna Publishers, 2-B Nath Market, Nai Sarak, New Delhi.
3. Khurmi, R. S. and Gupta, J. K. 2014. A Text Book of Machine Design. S. Chand & Company Ltd., New Delhi.
4. Sharma, P. C. and Agarwal, D. K. 2010. Machine Design. S. K. Kataria & Sons, New Delhi.

SEMESTER – 7

Sr. No.	Course Name	Course No.	Credit	L	P	T
7	Electrical Machines	REE7.7	3(2+1)	2	1	3

Objective

To make the students acquainted with operating principles of various electrical motors and other machines and to help them gain practical exposure of different electrical devices and their controls

Theory

Introduction to electrical machines; Basic principles of operation of electrical machines used in agricultural engineering such as DC generator, DC motor, 1-phase induction motor, 3-phase induction motor, and BLDC motor; Magnetic circuit: concept of magnetic flux production, magneto motive force, reluctance, laws of magnetic circuits, determination of ampere-turns for series and parallel magnetic circuits, hysteresis and eddy current losses

Transformer: principle of working, construction of single phase transformer, EMF equation, phasor diagram on load/ load, leakage reactance, voltage regulation, power and energy efficiency, open circuit and short circuit tests; D.C. machines: principles operation and performance of DC machine (generator and motor), EMF and torque equations, excitation of DC generator and their characteristics, DC motor characteristics, starting of shunt and series motor, starters, speed control methods-field and armature control

Three phase induction motor: construction, operation, types, concept of slip; slip speed and slip frequency, torque equation, torque-speed and torque-slip characteristics, maximum torque for starting and running condition. phasor diagram, starting and speed control methods; Single phase induction motor: principle of operation, double field revolving theory, equivalent circuit, characteristics, methods of starting, phase split, shaded pole motors, performance characteristics

Practical

To study different parts of DC/AC machines; To perform open circuit test on a single phase transformer and determine its iron loss as well as open circuit parameters; To perform short circuit test on a single phase transformer and hence find copper loss, equivalent circuit parameters, voltage regulation and efficiency; To study how to start the D.C motor using 3-point Starter; To start and run the D.C. motor (shunt, series & compound); To control the speed of DC shunt motor using flux control method; To control the speed of DC shunt motor using armature voltage control method; To conduct brake test on DC shunt motor and to determine its performance curves; To obtain the load characteristics of DC shunt motor and draw its characteristics; To start and run the 3-phase induction motor using star-delta starter and to find different voltage and current under star and delta connection; To perform no-load test on 3-phase induction motor and to determine its no-load losses; To perform blocked-

rotor tests on 3-phase induction motor to obtain the equivalent circuit parameters & to draw the circle diagram; To perform no load on 1-phase induction motor to determine its no-load losses; To perform blocked- rotor test on 1-phase induction motor & to determine the parameters of equivalent circuit on the basis of double revolving field theory; To perform load-test on 1-phase induction motor & plot torque-speed characteristic.

Planning of Lectures		
Sr. No	Topics to be covered in lecture	Proposed No. of Lectures
1.	Introduction to electrical machines;	2
2.	Basic principles of operation of electrical machines used in agricultural engineering such as DC generator, DC motor,	2
3.	1-phase induction motor, 3-phase induction motor, and BLDC motor; Magnetic circuit:	2
4.	concept of magnetic flux production, magneto motive force, reluctance,	2
5.	laws of magnetic circuits, determination of ampere-turns for series and parallel magnetic circuits, hysteresis and eddy current losses	2
6.	Transformer: principle of working, construction of single phase transformer,	2
7.	EMF equation, phasor diagram on load/ load, leakage reactance, voltage regulation,	2
8.	Power and energy efficiency, open circuit and short circuit tests	2
9.	D.C. machines: principles operation and performance of DC machine (generator and motor),	2
10.	EMF and torque equations, excitation of DC generator and their characteristics,	2
11.	DC motor characteristics, starting of shunt and series motor, starters, speed control methods-field and armature control	2
12.	Three phase induction motor:	2
13.	Construction, operation, types, concept of slip, Slip speed and slip frequency	2
14.	Torque equation, torque-speed and torque-slip characteristics, maximum torque for starting and running condition.	2
15.	Phasor diagram, starting and speed control methods;	2
16.	Single phase induction motor:	2
17.	Principle of operation, double field revolving theory, equivalent circuit, characteristics, methods of starting, phase split, shaded pole motors, performance characteristics	2
Total		34

Planning of Practical		
Sr. No	Topics to be covered in lecture	No. of Practical
1.	To study different parts of DC/AC machines;	1
2.	To perform open circuit test on a single phase transformer and determine its iron loss as well as open circuit parameters	1
3.	To perform short circuit test on a single phase transformer and hence	2

	find copper loss, equivalent circuit parameters, voltage regulation and efficiency;	
4.	To study how to start the D.C motor using 3-point Starter;	1
5.	To start and run the D.C. motor (shunt, series & compound)	1
6.	To control the speed of DC shunt motor using flux control method;	1
7.	To control the speed of DC shunt motor using armature voltage control method;	1
8.	To conduct brake test on DC shunt motor and to determine its performance curves;	1
9.	To obtain the load characteristics of DC shunt motor and draw its characteristics;	1
10.	To start and run the 3-phase induction motor using star-delta starter and to find different voltage and current under star and delta connection	1
11.	To perform no-load test on 3-phase induction motor and to determine its no-load losses;	1
12.	To perform blocked-rotor tests on 3-phase induction motor to obtain the equivalent circuit parameters & to draw the circle diagram;	1
13.	To perform no load on 1-phase induction motor to determine its no-load losses;	1
14.	To perform blocked- rotor test on 1-phase induction motor & to determine the parameters of equivalent circuit on the basis of double revolving field theory;	2
15.	To perform load-test on 1-phase induction motor & plot torque-speed characteristic.	1
Total		17

Suggested Reading

1. Anwani M L. 1997. *Basic Electrical Engineering*. Dhanpat Rai & Co. (P) LTD. New Delhi.
2. Shaney A K. 1997. *Measurement of Electrical and Electronic Instrumentation*. Khanna Publications
3. Thareja B L & Theraja A K. 2005. *A text book of Electrical Technology. Vol. I. S.* Chand & Company LTD., New Delhi.
4. Theraja B L & Theraja A K. 2005. *A text book of Electrical Technology. Vol. II.* S. Chand & Company LTD., New Delhi.
5. Boylestad, Robert L. and Louis N. 2015. *Electronic Devices and Circuit*, 11th edition, Pearson India

Semester – VII

Sr. No.	Course Name	Course No.	Credit	L	P	T
8	Agricultural Statistics and Data Analysis	AS 7.8	2(1+1)	1	1	2

Objective

To make the students acquainted with important statistical data analysis tools and application of these for research in agricultural engineering.

Theory

Introduction to statistics: definition, advantages and limitations; Data- types of data, quantitative and qualitative; variable - discrete and continuous; Frequency distribution table: construction of frequency distribution table (inclusive and exclusive)- number of classes, length of class, tally marks, frequency, class midpoint, cumulative frequencies, frequency curves, graphs and charts;

Measures of central tendency: definition, characteristics of ideal average, different measures; arithmetic mean, median, mode, geometric mean and harmonic mean for grouped & ungrouped data, merits and demerits; Measures of dispersion: definition, different measures (absolute & relative); range, quartile deviation, mean deviation, standard deviation (SD), variance and coefficient of variation;

Probability: Definition and concept of probability; Random variable: concept of random variable and expectation; Simple linear correlation: concept, definition, types and its properties; Simple linear regression: concept, definition and its properties; Normal distribution: definition, density function, curve, properties, standard normal distribution (SND), properties including area under the curve (without proof); Binomial distribution: definition, density function and properties; Poisson distribution: definition, density function and properties; Introduction to sampling: definition of statistical population, sample, random sampling, parameter, statistic, sampling distribution, concept of standard error of mean;

Testing of hypothesis – hypothesis, null hypothesis, types of hypothesis, level of significance, degrees of freedom – statistical errors; Large Sample test (Z-test), small sample t-test (one tailed, two tailed and paired tests); Testing of significance through variance (F-test), Chi-square test: goodness of fit & testing of independence of attributes (2x2 contingency table).

Practical

Construction of frequency distribution tables and frequency curves; Computation of arithmetic mean, median and mode for un-grouped and grouped data; Computation of harmonic and geometric mean; Computation of standard deviation (SD); Variance and coefficient of variation for un-grouped and grouped data; Computation of skewness, kurtosis; Standard normal distribution test for single sample mean (population SD known & unknown); SND test for two samples means (population SD known & unknown); Computation of binomial distribution; Computation of Poisson distribution; Calculation of correlation coefficient and its testing; Calculation of regression coefficient, regression line; Student’s t-test for single sample mean; t-test for two samples means; Paired t test; F– test for equality for two sample variance test; Computation of Chi-square test: goodness of fit & testing of independence of attributes (2x2 contingency table) and m×n.

Planning of Lectures		
Sr. No	Topics to be covered in lecture	Proposed No. of Lectures
1.	Introduction to statistics: definition, advantages and limitations; Data- types of data, quantitative and qualitative; variable - discrete	2

	and continuous; Frequency distribution table: construction of frequency distribution table (inclusive and exclusive)- number of classes, length of class, tally marks, frequency, class midpoint, cumulative frequencies, frequency curves, graphs and charts;	
2.	Measures of central tendency: definition, characteristics of ideal average, different measures; arithmetic mean, median, mode, geometric mean and harmonic mean for grouped & ungrouped data, merits and demerits; Measures of dispersion: definition, different measures (absolute & relative); range, quartile deviation, mean deviation, standard deviation (SD), variance and coefficient of variation	2
3.	Probability: Definition and concept of probability; Random variable: concept of random variable and expectation	1
4.	Simple linear correlation: concept, definition, types and its properties; Simple linear regression: concept, definition and its properties	1
5.	Normal distribution: definition, density function, curve, properties, standard normal distribution (SND), properties including area under the curve (without proof);	2
6.	Binomial distribution: definition, density function and properties; Poisson distribution: definition, density function and properties;	1
7.	Introduction to sampling: definition of statistical population, sample, random sampling, parameter, statistic, sampling distribution, concept of standard error of mean	1
8	Testing of hypothesis – hypothesis, null hypothesis, types of hypothesis, level of significance, degrees of freedom – statistical errors; Large Sample test (Z-test), small sample t-test (one tailed, two tailed and paired tests);	3
9.	Testing of significance through variance (F-test), Chi-square test: goodness of fit & testing of independence of attributes (2x2 contingency table).	3
Total		16

Planning of Practicals		
Sr. No	Topics to be covered in lecture	No. of Practical
1.	Construction of frequency distribution tables and frequency curves; Computation of arithmetic mean, median and mode for un-grouped and grouped data	2
2.	Computation of harmonic and geometric mean; Computation of standard deviation (SD); Variance and coefficient of variation for un-grouped and grouped data	2
3.	Computation of skewness, kurtosis; Standard normal distribution test for single sample mean (population SD known & unknown); SND test for two samples means (population SD known & unknown)	3

4.	Computation of binomial distribution; Computation of Poisson distribution; Calculation of correlation coefficient and its testing; Calculation of regression coefficient, regression line	3
5.	Student's t-test for single sample mean; t-test for two samples means; Paired t test	3
6.	F- test for equality for two sample variance test; Computation of Chi-square test: goodness of fit & testing of independence of attributes (2x2 contingency table) and m×n.	3
Total		16

Suggested Reading

1. Chandel S R S. 1999. *A Hand book of Agricultural Statistics*. Achal Prakasan Mandir, Kanpur
2. Agrawal B L. 1991. *Basic Statistics*. Wiley Eastern Ltd. New Age International Ltd.
3. Nageswara Rao G. 2007. *Statistics for Agricultural Sciences*. BS Publications.
4. Rangaswamy R. 2018. *A Text Book of Agricultural Statistics*. New Age Int. publications Ltd.
5. Gupta S C and Kapoor V K. 2019. *Fundamental Applied Statistics*. Sultan Chand & Sons.
6. Gupta S C and Kapoor V K. 1970. *Fundamentals of Mathematical Statistics*. Sultan Chand & Sons.

Sr. No.	Course Number	Course Title	Credit Hours	Total Credit Hours
Fourth Year				
VIII semester				
1	SEC8.1	Project -II	4 (0+4)	13 (6+7)
2	As per list- α	Elective- I	3 (2+1)	
3	As per list- α	Elective- II	3 (2+1)	
4	As per list- α	Elective- III	3 (2+1)	
5				
			TOTAL	175 (95+80)
*On-line courses			6	6

Select any 3 from the following listed Elective courses As per list- α below

SN	Course code	Course title	Credit Hours	Discipline
1	FMPE8.3	Mechanics of Tillage and Traction	3 (2+1)	FMPE
2	FMPE8.4	Farm Machinery Design and Production	3 (2+1)	FMPE
3	FMPE8.5	Tractor Design and Testing	3 (2+1)	FMPE
4	FMPE8.6	Hydraulic Drives and Controls	3 (2+1)	FMPE
5	FMPE8.7	Human Engineering and Safety	3 (2+1)	FMPE
6	FMPE8.8	Precision Agriculture and System Management	3 (2+1)	FMPE
7	REE8.9	Photovoltaic Technology and Systems	3 (2+1)	REE
8	REE8.10	Wind Power Technology and Systems	3 (2+1)	REE
9	REE8.11	Waste and By-products Utilization	3 (2+1)	REE
10	SWCE8.12	Floods and Control Measures	3 (2+1)	SWCE
11	SWCE8.13	Remote Sensing and GIS Applications	3 (2+1)	SWCE
12	SWCE8.14	Information Technology for Land and Water Management	3 (2+1)	SWCE
13	SWCE8.15	Wasteland Development	3 (2+1)	SWCE
14	IDE8.16	Minor Irrigation and Command Area Development	3 (2+1)	IDE
15	IDE8.17	Management of Canal Irrigation System	3 (2+1)	IDE
16	IDE8.18	Water Quality and Management Measures	3 (2+1)	IDE
17	IDE8.19	Landscape Irrigation Design and Management	3 (2+1)	IDE
18	AS8.20	Application of Plastics in Agriculture	3 (2+1)	REE
19	AS8.21	Precision Farming Techniques for Protected Cultivation	3 (2+1)	REE

20	PFE8.22	Environmental Engineering	3 (2+1)	REE
21	PFE8.23	Development of Processed Food Products	3 (2+1)	PFE
22	PFE8.24	Food Packaging Technology	3 (2+1)	PFE
23	PFE8.25	Food Plant and Equipment Design	3 (2+1)	PFE
24	PFE8.26	Emerging Technologies in Food Processing	3 (3+0)	PFE
25	PFE8.27	Processing of Livestock, Fish and Marine Products	3 (2+1)	PFE
26	PFE8.28	Food Business Management and Entrepreneurship Development	3 (3+0)	PFE
27	CSE8.29	MATLAB Programming	3 (1+2)	Computer
28	CSE8.30	Python Programming	3 (1+2)	Computer
29	CSE8.31	Artificial Intelligence	3 (2+1)	Computer
30	CSE8.32	Advances in Automation and Robotics in Agriculture	3 (2+1)	Computer
31	CSE8.33	Machine Learning	3 (2+1)	Computer
32	AS8.34	Operations Research	3 (3+0)	FMPE
33	FMPE8.35	Mechatronics	3 (2+1)	FMPE
34	PFE8.36	Natural Fibers: Extraction & Properties	3 (2+1)	PFE
35	PFE8.37	Natural Fiber Applications in Agriculture	3 (2+1)	PFE
36	PFE8.38	Processing of Natural Fibers	3 (2+1)	PFE
37	MDC-III	Agriucultural Marketing & Trade	3 (2+1)	PFE

SEMESTER – 8 (Elective course)

Sr. No.	Course Name	Course No.	Credit	L	P	T
1	Mechanics of Tillage and Traction	FMPE 8.3	3 (2+1)	2	1	3

Objective

To enable the students to

1. Know various engineering properties of soil and to understand the effect of these properties on the performance of tillage tools
2. Know the application of dimensional analysis on soil dynamics and traction
3. Understand the effect of soil compaction on crop growth
4. Know the use of GIS in soil dynamics

Theory

Introduction to mechanics of tillage tools, engineering properties of soil, principles and concepts, stress strain relationship; Design of tillage tools, principles of soil cutting, design equation, force analysis; Application of dimensional analysis in soil dynamics and traction prediction equation.

Introduction to traction and mechanics, off-road traction and mobility, traction model, traction improvement, tyres-functions, size, lug geometry and their effects, tyre selection and testing; Soil compaction and plant growth and variability; Application of GIS in soil dynamics.

Practical

Measurement of static and dynamic soil parameters related to tillage; Soil parameters related to puddling and floatation; Draft for passive rotary and oscillating tools, slip and sinkage under dry and wet soil conditions and load and fuel consumption for different farm operations; Weight transfer and tractor loading including placement and traction aids; Studies on tyres, tracks and treads under different conditions, and soil compaction and number of operations.

Planning of Lectures		
Sr. No	Topics to be covered in Lectures	No. of Lectures
1	Introduction to mechanics of tillage tools	2
2	Engineering properties of soil	4
3	Principles and concepts, stress strain relationship	3
4	Design of tillage tools, principles of soil cutting, design equation, force analysis	4
5	Application of dimensional analysis in soil dynamics and traction prediction equation.	3
6	Introduction to traction and mechanics	3
7	Off-road traction and mobility, traction model, traction improvement, tyres-functions, size, lug geometry and their effects	3
8	Tyre selection and testing	3
9	Soil compaction and plant growth and variability	3
10	Application of GIS in soil dynamics.	4
		32

Planning of Practical		
Sr. No	Topics to be covered in Practical	No. of Practical

1	Measurement of static and dynamic soil parameters related to tillage	2
2	Soil parameters related to puddling and floatation	2
3	Draft for passive rotary and oscillating tools	2
4	slip and sinkage under dry and wet soil conditions and load	2
5	Fuel consumption for different farm operations	3
6	Weight transfer and tractor loading including placement and traction aids	3
7	Studies on tyres, tracks and treads under different conditions, and soil compaction and number of operations	2
Total		16

Suggested Reading

1. Gill and Vandenberg. 1968. Soil Dynamics in Tillage and Traction. Agricultural Research Service, USDA, Govt. Printing Press, Washington, D.C.
2. Liljedahl, J. B., Turnquist, P. K., Smith, D. W. and Hoki, M. 2004. Tractors and their Power Units. CBS Publishers
3. Macmillan R H. 2002. The Mechanics of Tractor-Implement Performance. International Development Technologies Centre, University of Melbourne.
4. Terzaghi K and Peck R B and Mesri G. 1996. Soil Mechanics in Engineering Practices. John Willey & Sons.

SEMESTER – 8 (Elective course)

Sr. No.	Course Name	Course No.	Credit	L	P	T
2	Farm Machinery Design and Production	FMPE 8.4	3 (2+1)	2	1	3

Objective

To enable the students to design farm machinery and to understand the production principles

Theory

Introduction to design parameters of agricultural machines and design procedure, characteristics of farm machinery design, research and development aspects of farm machinery; Introduction to safety in power transmission; Design of standard power transmission components used in agricultural machines: mechanical and hydraulic units; Application of design principles to the systems of selected farm machines such as design of disc plough, cultivator, seed drill, reaper, thresher and digger; Critical appraisal in production of agricultural machinery, advances in material used for agricultural machinery; Cutting tools including CNC tools and finishing tools; Heat treatment of steels including pack carburizing, shot pining process, etc., limits, fits and tolerances, jigs and fixtures; Industrial lay-out planning, quality production management, reliability; Economics of process selection, familiarization with project report.

Practical

Familiarization with different design aspects of farm machinery and selected components; Solving design problems on farm machines and equipment; Visit to agricultural machinery manufacturing industry, tractor manufacturing industry; Study of jigs and fixtures in relation to agricultural machinery; Study of fits, tolerances and limits; Layout planning of a small scale industry; Problems on economics of process selection; Preparation of a project report; Case study for manufacturing of simple agricultural machinery.

Planning of Lectures		
Sr. No	Topics to be covered in Lectures	No. of Lectures

1	Introduction to design parameters of agricultural machines and design procedure	2
2	Characteristics of farm machinery design, research and development aspects of farm machinery	3
3	Introduction to safety in power transmission	2
4	Design of standard power transmission components used in agricultural machines: mechanical and hydraulic units	2
5	Application of design principles to the systems of selected farm machines such as design of disc plough, cultivator, seed drill, reaper, thresher and digger	5
6	Critical appraisal in production of agricultural machinery	2
7	Advances in material used for agricultural machinery	2
8	Cutting tools including CNC tools and finishing tools	3
9	Heat treatment of steels including pack carburizing, shot pining process, etc., limits, fits and tolerances, jigs and fixtures	3
10	Industrial lay-out planning	2
11	Quality production management, reliability	2
12	Economics of process selection,	2
13	Familiarization with project report.	2
		32

Planning of Practical		
Sr. No	Topics to be covered in Practical	No. of Practical
1	Familiarization with different design aspects of farm machinery and selected components	2
2	Solving design problems on farm machines and equipment	2
3	Visit to agricultural machinery manufacturing industry	1
4	Visit to tractor manufacturing industry	1
5	Study of jigs and fixtures in relation to agricultural machinery	2
6	Study of fits, tolerances and limits	2
7	Layout planning of a small scale industry	2
8	Problems on economics of process selection	2
9	Preparation of a project report	1
10	Case study for manufacturing of simple agricultural machinery	1
	Total	16

Suggested Reading

1. Adinath, M. and Gupta, A. B. 1996. Manufacturing Technology. New Age International (P) Ltd.
2. Narula, V. 2009. Manufacturing Processes. S K Kataria & Sons, New Delhi.
3. Richey, C. B. 1961. Agricultural Engineering Handbook. McGraw-Hill Inc., US.
4. Sharma, D. N. and Mukesh, S. 2021. Farm Machinery Design (Principles and Problems). 4th Revised Edition. Jain Brothers, New Delhi.
5. Sharma, P. C. and Aggarwal, D. K. 2010. Machine Design. S K Kataria & Sons, New Delhi.
6. Singh, S. 2016. Mechanical Engineer's Handbook. Khanna Publications, New Delhi.

SEMESTER – 8 (Elective course)

Sr. No.	Course Name	Course No.	Credit	L	P	T
3	Tractor Design and Testing	FMPE 8.5	3 (2+1)	2	1	3

Objective

To enable the students to understand

1. Parameters for balanced design of tractor for stability and weight distribution
2. Special design features of tractor engines and their selection, viz. cylinder, piston, piston pin, crankshaft, etc.
3. Perform testing of tractor

Theory

Procedure for design and development of agricultural tractor; Study of parameters for balanced design of tractor for stability and weight distribution; Traction theory, hydraulic lift and hitch system design; Design of mechanical power transmission in agricultural tractors: single disc, multi disc and cone clutches; Rolling friction and anti-friction bearings; Design of Ackerman Steering and tractor hydraulic steering; Study of special design features of tractor engines and their selection, viz. cylinder, piston, piston pin, crankshaft, etc.; Design of seat and controls of an agricultural tractor; Tractor Testing.

Practical

Design problem of tractor clutch (single/multiple disc clutch); Design of gear box (synchromesh/constant mesh), variable speed constant mesh drive; Selection of tractor tires; Problem on design of governor; Design and selection of hydraulic pump; Engine testing as per BIS code; Drawbar performance in the lab; PTO test and measure the tractor power in the lab/field; Determining the turning space, turning radius and brake test; Hydraulic pump performance test and air cleaner and noise measurement test; Visit to tractor testing centre/ industry.

Planning of Lectures		
Sr. No	Topics to be covered in Lectures	No. of Lectures
1	Procedure for design and development of agricultural tractor	2
2	Study of parameters for balanced design of tractor for stability and weight distribution	3
3	Traction theory	3
4	Hydraulic lift and hitch system design	3
5	Design of mechanical power transmission in agricultural tractors: single disc, multi disc and cone clutches	4
6	Rolling friction and anti-friction bearings	2
	Design of Ackerman Steering and tractor hydraulic steering	3
7	Study of special design features of tractor engines and their selection, viz. cylinder, piston, piston pin, crankshaft, etc.	4
8	Design of seat and controls of an agricultural tractor	3
9	Tractor Testing	5
	Total	32

Planning of Practical		
Sr. No	Topics to be covered in Practical	No. of Practical
1	Design problem of tractor clutch (single/multiple disc clutch)	1

2	Design of gear box (synchromesh/ constant mesh), variable speed constant mesh drive	1
3	Selection of tractor tires	1
4	Problem on design of governor	1
5	Design and selection of hydraulic pump	2
6	Engine testing as per BIS code; Drawbar performance in the lab; PTO test and measure the tractor power in the lab/field	3
7	Determining the turning space, turning radius and brake test	2
8	Hydraulic pump performance test	1
9	Air cleaner Test	1
10	Noise and vibration measurement test	2
11	Visit to tractor testing centre/ industry	1
	Total	16

Suggested Reading

1. Liljedahl, J. B., Turnquist, P. K., Smith, D. W. and Hoki, M. 2004. Tractors and their Power Units. CBS Publishers and Distributors Pvt. Ltd.
2. Maleev, V. L. 1964. Internal Combustion Engines. McGraw-Hill Inc., US.
3. Mehta, M. L., Verma, S. R., Mishra, S. K. and Sharma, V. K. 1995. Testing and Evaluation of Agricultural Machinery. National Agricultural Technology Information Centre. Ludhiana.
4. Richey, C. B. 1961. Agricultural Engineering Handbook. McGraw-Hill Inc., US.
5. Singh, K. 2018. Automobile Engineering – Vol I and Vol II. Standard Publishers and Distributors. New Delhi.

SEMESTER – 8 (Elective course)

Sr. No.	Course Name	Course No.	Credit	L	P	T
4	Hydraulic Drives and Controls	FMPE 8.6	3 (2+1)	2	1	3

Objective

To enable the students to understand the basic principles of hydraulic power system and tractor hydraulic system and different control measures

Theory

Basics of hydraulics: Pascal's law, flow, energy, work, and power; Hydraulic systems, colour coding, reservoirs, strainers and filters, filtering material and elements, accumulators, pressure gauges and volume meters; Hydraulic circuit, fittings and connectors; Pumps and its classifications, operation, performance, displacement; Design of gear pumps, vane pumps, piston pumps. hydraulic actuators; Cylinders, construction and applications, maintenance; Hydraulic motors, valves, pressure-control valves, directional- control valves, flow-control valves, valve installation, valve failures and remedies, valve assembly, troubleshooting of valves; Hydraulic circuit diagrams; USA Standards Institute (USASI) symbols; Tractor hydraulics, nudging system, ADDC, application of hydraulics and pneumatics drives in agricultural systems.

Practical

Introduction to hydraulic systems; Study of hydraulic pumps, hydraulic actuators; Study of hydraulic motors, hydraulic valves, colour codes and circuits; Building simple hydraulic circuits, hydraulics in tractors; Introduction to pneumatics, pneumatics devices, pneumatics in agriculture

Planning of Lectures		
Sr. No	Topics to be covered in Lectures	No. of Lectures
1	Basics of hydraulics: Pascal's law, flow, energy, work, and power	2
2	Hydraulic systems, colour coding, reservoirs	2
3	Strainers and filters, filtering material and elements, accumulators	2
4	Pressure gauges and volume meters	2
5	Hydraulic circuit, fittings and connectors	2
6	Pumps and its classifications, operation, performance, displacement	2
	Design of gear pumps, vane pumps, piston pumps	3
7	hydraulic actuators; Cylinders, construction and applications, maintenance	3
8	Hydraulic motors	2
9	Valves, pressure-control valves, directional- control valves, flow-control valves, valve installation, valve failures and remedies, valve assembly, troubleshooting of valves	4
10	Hydraulic circuit diagrams	2
11	USA Standards Institute (USASI) symbols	1
12	Tractor hydraulics, nudging system, ADDC	2
13	Application of hydraulics and pneumatics drives in agricultural systems	3
	Total	32

Planning of Practical		
Sr. No	Topics to be covered in Practical	No. of Practical
1	Introduction to hydraulic systems	1
2	Study of hydraulic pumps	2
3	Study of hydraulic actuators	2
4	Study of hydraulic motors	1
5	Study of hydraulic valves	2
6	Study of colour codes and circuits	1
7	Building simple hydraulic circuits	1
8	Study of hydraulics in tractors	2
9	Introduction to pneumatics, pneumatics devices	2
10	Study of pneumatics in agriculture	2
	Total	16

Suggested Reading

1. Anthony, E. 2014. Fluid Power and Applications. Pearson Education Limited. USA.
2. Kepner, R. A., Roy, B. and E. L. B. 2000. Principles of Farm Machinery. CBC Publishers & Distributors, New Delhi.
3. Kuhar, J. E. (Ed.). 1992. Hydraulics (Fundamentals of Service Series). John Deere and Co.
4. Majumdar, S. 2002. Oil Hydraulic System: Principles and Maintenance. McGraw-Hill
5. Meritt, H. E. 1991. Hydraulic Control Systems. John Wiley & Sons.

SEMESTER – 8 (Elective course)

Sr. No.	Course Name	Course No.	Credit	L	P	T
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5	Human Engineering and Safety	FMPE 8.7	3 (2+1)	2	1	3
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Objective

To enable the students to understand the importance of human factors/ human engineering in farm machine design as well as for Implementation of ODMR and other safety aspects in farm operation

Theory

Human factors in system development- concept of systems, basic processes in system development, performance reliability, human performance; Information input process, visual displays, major types and use of displays, auditory displays; Speech communications; Biomechanics of motion, types of movements, range of movements, strength and endurance, speed and accuracy, human control of systems; Human motor activities, controls, tools and related devices; Anthropometry: arrangement and utilization of work space, atmospheric conditions, thermo- regulation in human, thermal comfort, environmental factors, air pollution; Dangerous machine (Regulation) act, rehabilitation and compensation to accident victims; Safety gadgets for spraying, threshing, chaff cutting and tractor and trailer operation, etc.

Practical

Calibration of the subject in the laboratory using bi-cycle ergo-meter; Study and calibration of the subject in the laboratory using mechanical treadmill; Use of respiration gas meter from human energy point of view; Use of heart rate monitor; Study of general fatigue of the subject. using Blink ratio method, anthropometric measurements of a selected subject; Optimum work space layout and locations of controls for different tractors; Familiarization with the noise and vibration equipment; Familiarization with safety gadgets for various farm machines; Studies on drudgery of farm women in manual drawn equipment.

Planning of Lectures		
Sr. No	Topics to be covered in Lectures	No. of Lectures
1	Human factors in system development- concept of systems	2
2	Basic processes in system development, performance reliability, human performance	3
3	Information input process, visual displays, major types and use of displays, auditory displays; Speech communications	3
4	Biomechanics of motion, types of movements, range of movements	3
5	Strength and endurance, speed and accuracy, human control of systems	3
6	Human motor activities, controls, tools and related devices	2
	Anthropometry: arrangement and utilization of work space	3
7	Atmospheric conditions, thermo- regulation in human, thermal comfort	3
8	Environmental factors, air pollution	2
9	Dangerous machine (Regulation) act, rehabilitation and compensation to accident victims	3
10	Safety gadgets for spraying, threshing, chaff cutting and tractor and trailer operation, etc.	5
	Total	32

Planning of Practical		
Sr. No	Topics to be covered in Practical	No. of Practical
1	Calibration of the subject in the laboratory using bi-cycle ergo-meter	1

2	Study and calibration of the subject in the laboratory using mechanical treadmill	1
3	Use of respiration gas meter from human energy point of view	1
4	Use of heart rate monitor	1
5	Study of general fatigue of the subject-using Blink ratio method	2
6	Anthropometric measurements of a selected subject	2
7	Optimum work space layout and locations of controls for different tractors	2
8	Familiarization with the noise measurement equipment	1
	Familiarization with the vibration measurement equipment	1
9	Familiarization with safety gadgets for various farm machines	2
10	Studies on drudgery of farm women in manual drawn equipment	2
	Total	16

Suggested Reading

1. Astrand, P. and Rodahl, K. 1977. Textbook of Work Physiology. Mc Hill Corporation, New York.
2. Chapanis, A. 1996. Human Factors in System Engineering. John Wiley & Sons, New York.
3. Dul, J. and Weerdmeester, B. 1993. Ergonomics for Beginners. A Quick Reference Guide. Taylor and Francis, London.
4. Keegan, J. J. and Radke, A. O. 1964. Designing Vehicle Seats for Greater Comfort. SAE Journal, 72:50~5.
5. Mark, S. S. and McCormick, E. J. 1993. Human Factors in Engineering and Design. Mc Hill Corporation, New York.
6. Mathews, J. and Knight, A. A. 1971. Ergonomics in Agricultural Equipment Design. National Institute of Agricultural Engineering.
7. Yadav, R. and Tewari, V. K. 1998. Tractor Operator Workplace Design-A Review. Journal of Terra mechanics, 35: 41-53.

SEMESTER – 8 (Elective course)

Sr. No.	Course Name	Course No.	Credit	L	P	T
6	Precision Agriculture and System Management	FMPE 8.8	3 (2+1)	2	1	3

Objective

- 1.To enable the students to understand the principles of precision agriculture and system management and the use of different equipment in precision agriculture
- 2.To learn the GIS based precision agriculture, sensors and application of sensors for data generation

Theory

Precision agriculture- need and functional requirements; Familiarization with issues relating to natural resources; Equipment for precision agriculture including sowing and planting machines, power sprayers, land clearing machines, laser guided land levelers, straw-chopper, straw-balers, grain combines, etc.; Introduction to GIS based precision agriculture and its applications; Introduction to sensors and application of sensors for data generation; Database management; System concept, system approach in farm machinery management, problems on machinery

selection, maintenance and scheduling of operations; Application of PERT and CPM in machinery system management.

Practical

Familiarization with precision agriculture problems and issues; Familiarization with various machines for resource conservation; Solving problems related to various capacities, pattern efficiency, system limitation, etc; Problems related to cost analysis, inflation and problems related to selection of equipment, replacement, break-even analysis, time value of money, etc.

Planning of Lectures		
Sr. No	Topics to be covered in Lectures	No. of Lectures
1	Precision agriculture- need and functional requirements	2
2	Familiarization with issues relating to natural resources	3
3	Equipment for precision agriculture including sowing and planting machines	3
4	Study of power sprayers	2
5	Study of land clearing machines	2
6	Study of laser guided land levelers	1
7	Study of straw-chopper, straw-balers, grain combines, etc.	3
8	Introduction to GIS based precision agriculture and its applications	3
9	Introduction to sensors and application of sensors for data generation	2
10	Database management; System concept, system approach in farm machinery management	3
11	Problems on machinery selection	4
12	Maintenance and scheduling of operations	2
13	Application of PERT and CPM in machinery system management	2
		32

Planning of Practical		
Sr. No	Topics to be covered in Practical	No. of Practical
1	Familiarization with precision agriculture problems and issues	2
2	Familiarization with various machines for resource conservation	2
3	Solving problems related to various capacities	2
4	Study of pattern efficiency, system limitation, etc	2
5	Problems related to cost analysis	2
6	Inflation effect on cost analysis and problems related to selection of equipment	2
7	Study of replacement criteria and problems related to it	2
8	Break-even analysis, time value of money, etc.	2
	Total	16

Suggested Reading

1. DeMers M N. 2008. Fundamentals of Geographic Information Systems. Wiley.
2. Dutta, S. K. 1987. Soil Conservation and Land Management. International Book Distributors. Dehradun.
3. Hunt, D. 1956. Farm Power and Machinery Management. Iowa State College Press.
4. Kuhar, J. E. 1977. The Precision Farming Guide for Agriculturist. Lori J. Dhabalt, USA.

5. Sharma, D. N., Jain, M. and Lohan, S. K. 2021. Farm Power and Machinery Management. Jain Brothers.
6. Sigma and Jagmohan. 1976. Earth Moving Machinery. Oxford & IBH
7. Wood, S. 1977. Heavy Construction: Equipment and Methods. Prentice Hall

SEMESTER – 8 (Elective course)

Sr. No.	Course Name	Course No.	Credit	L	P	T
7	Photovoltaic Technology and Systems	REE8.9	3(2+1)	2	1	3

Objective

To enable the students to understand the basic elements of photovoltaics, working of PV cells, designs of PV systems and to know the installation of PV system both off grid and on grid

Theory

Solar PV Technology: advantages, limitations, current status of PV technology, SWOT analysis of PV technology; Types of solar cells: Wafer based silicon cell, Thin film amorphous silicon cell, Thin Cadmium Telluride (CdTe) Cell, Copper Indium Gallium Selenide (CiGS) Cell, Thin film crystalline silicon solar cell; Solar photo voltaic module: solar cell, solar module, solar array, series & parallel connections of cell, mismatch in cell, fill factor, effect of solar radiation and temperature on power output of module, I-V and power curve of module, balance of solar PV system; Solar PV system designing and cost estimation;

Introduction to batteries, battery classification, lead acid battery, Nicked Cadmium battery, comparison of batteries, battery parameters; Charge controller: types and function of charge controller, PWM (Pulse width modulation) type, MPPT (Maximum Power Point Tracking) type charge controller; Converters: DC to DC converter and DC to AC type converter;

Application of solar PV system, solar home lighting system, solar lantern, solar fencing, solar street light, solar water pumping system, roof top solar photovoltaic power plant and smart grid

Practical

Study of V-I characteristics of solar PV system; Smart grid technology and application; Manufacturing technique of solar array; Different DC to DC and DC to AC converter; Domestic solar lighting system; Various solar module technologies; Safe measurement of PV modules electrical characteristics and commissioning of complete solar PV system.

Planning of Lectures		
Sr. No	Topics to be covered in lecture	Proposed No. of Lectures
1.	Solar PV Technology:	1
2.	advantages, limitations, current status of PV technology,	2
3.	SWOT analysis of PV technology;	2
4.	Types of solar cells	1
5.	Wafer based silicon cell, Thin film amorphous silicon cell, Thin Cadmium Telluride (CdTe) Cell, Copper Indium Gallium Selenide (CiGS) Cell,	3

6.	Thin film crystalline silicon solar cell;	2
7.	Solar photo voltaic module: solar cell, solar module, solar array, series & parallel connections of cell,	2
8.	mismatch in cell, fill factor, effect of solar radiation and temperature on power output of module,	3
9.	I-V and power curve of module, balance of solar PV system; Solar PV system designing and cost estimation;	3
10.	Introduction to batteries, battery classification, lead acid battery, Nicked Cadmium battery, comparison of batteries, battery parameters	3
11.	Charge controller: types and function of charge controller,	2
12.	PWM (Pulse width modulation) type,	2
13.	MPPT (Maximum Power Point Tracking) type charge controller;	2
14.	Converters: DC to DC converter and DC to AC type converter;	2
15.	Application of solar PV system, solar home lighting system, solar lantern, solar fencing,	2
16.	solar street light, solar water pumping system, roof top solar photovoltaic power plant and smart grid	2
Total		34

Practical

Planning of Practical		
Sr. No	Topics to be covered in lecture	No. of Practical
1.	Study of V-I characteristics of solar PV system	2
2.	Smart grid technology and application;	2
3.	Manufacturing technique of solar array;	2
4.	Different DC to DC and DC to AC converter;	3
5.	Domestic solar lighting system	2
6.	Various solar module technologies;	2
7.	Safe measurement of PV modules electrical characteristics and commissioning of complete solar PV system.	4
Total		17

Suggested Reading

1. Rai G D. 1998. *Non-conventional Sources of Energy*. Khanna Pub.
2. Rathore N S, Kurchania A K and Panwar N L. 2006. *Renewable Energy: Theory & Practice*. Himanshu Publications.
3. Solanki C S. 2011. *Solar Photovoltaic: Fundamentals, Technologies and Applications*. PHI Learning Private Ltd.
4. Meinel A B and Meinel M P. 1976. *Applied Solar Energy: An Introduction*. Addison-Wesley Educational Publishers Inc.
5. Derrick A, Francis C and Bokalders V. 1991. *Solar Photo-voltaic Products*. Intermediate Technology Publications.

SEMESTER – 8 (Elective course)

Sr. No.	Course Name	Course No.	Credit	L	P	T

8	Wind Power Technology and Systems	REE8.10	3(2+1)	2	1	3
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Objective

To enable the students to calculate and analyse wind resource and energy production from a wind turbine, Understand the typical control methods for wind turbines and the modes of wind power generation

Theory

Aerodynamic operations of wind turbines; Wind energy extraction and wind turbine power generation; Design of wind turbine rotors, estimation of wind turbine power rating, selection of optimum wind energy generator; Types of wind energy systems, wind to electrical energy conversion alternatives, grid interfacing of a wind farm, grid connection, energy storage requirements with wind energy system

Economics of wind energy system; Modes of wind power generation; standalone mode, wind diesel hybrid system, solar wind hybrid system; Control and monitoring system of a wind farm, wind farm siting; Wind map of India, wind-electric energy stations in India.

Practical

Detailed design and drawing of wind turbine; Study of horizontal axis wind turbine; Study of vertical axis wind turbine; Study of variation of wind speed with elevation; Study of validation of Weibull probability density function; Study of wind power density duration curve; Electrical characteristics and commissioning of complete aero-generator wind power system; Visit to a wind farm.

Planning of lectures		
S.No.	Topics to be covered in Lecture	Proposed No. of Lectures
1	Aerodynamic operations of wind turbines;	3
2	Wind energy extraction and wind turbine power generation;	3
3	Design of wind turbine rotors, estimation of wind turbine power rating, selection of optimum wind energy generator;	4
4	Types of wind energy systems, wind to electrical energy conversion alternatives,	3
5	grid interfacing of a wind farm, grid connection,	3
6	energy storage requirements with wind energy system	3
7	Economics of wind energy system;	3
8	Modes of wind power generation;	3
9	standalone mode, wind diesel hybrid system, solar wind hybrid system;	3
10	Control and monitoring system of a wind farm, wind farm siting;	3
11	Wind map of India, wind-electric energy stations in India.	3
	Total	34

Practicals

S.No.	Topic	No. of Practicals
1	Detailed design and drawing of wind turbine;	2
2	Study of horizontal axis wind turbine;	2
3	Study of vertical axis wind turbine;	2
4	Study of variation of wind speed with elevation;	2
5	Study of validation of Weibull probability density function;	2
6	Study of wind power density duration curve;	2
7	Electrical characteristics and commissioning of complete aero-generator wind power system;.	3
8	Visit to a wind farm	2
	Total	17

Suggested Reading

1. Rai G D. 1998. *Non-conventional Sources of Energy*. Khanna Publisher, New Delhi.
2. Tiwari G N and Ghosal M K. 2005. *Renewable Energy Resources: Basic Principles and Applications*. Narosa Publishing House, New Delhi.
3. Powar A G and Mohod A G. 2010. *Fundamentals of wind energy utilization*. Jain Brothers Publisher, Karol Bagh, New Delhi.
4. Kothari D P, Singal K C and Ranjan R. 2012. *Renewable energy sources and emerging technologies*. PHI Learning Private Limited. New Delhi.
5. Rao S and Parulekar B B. 2007. *Energy Technology*. Khanna Publishers, New Delhi.
6. Rathore N S, Kurchania A K and Panwar N L. 2006. *Renewable Energy: Theory & Practice*. Himanshu Publications, Udaipur.
7. Solanki C S. 2011. *Solar Photovoltaic : Fundamentals, Technologies and Applications*. PHI Learning Private Ltd., New Delhi.

SEMESTER – 8 (Elective course)

Sr. No.	Course Name	Course No.	Credit	L	P	T
9	Waste and By-products Utilization	REE8.11	3(2+1)	2	1	3

Objective

To enable the students to understand the nature of agricultural wastes and the physical, chemical and biological basis of agricultural waste treatment as well as to analyse and design systems for the collection, handling, treatment and utilization of wastes

Theory

Types and formation of by-products and waste; Magnitude of waste generation in different food processing industries; Uses of different agricultural by-products from rice mill, sugarcane industry, oil mill etc.;

Concept, scope and maintenance of waste management and effluent treatment; Waste parameters and their importance in waste management- temperature, pH, Oxygen demands (BOD, COD), fat, oil and grease content, metal content, forms of phosphorous and sulphur in waste waters, microbiology of waste, other ingredients like insecticide, pesticides and fungicides residues

Waste utilization in various industries, furnaces and boilers run on agricultural wastes and by products, briquetting of biomass as fuel, production of charcoal briquette, generation of

electricity using surplus biomass, producer gas generation and utilization; Waste treatment and disposal: Design, construction, operation and management of institutional community and family size biogas plants, vermi- composting;

Pre-treatment of waste: sedimentation, coagulation, flocculation and floatation; Secondary treatments: biological and chemical oxygen demand for different food plant waste– trickling filters, oxidation ditches, activated sludge process, rotating biological contractors, lagoons; Tertiary treatments: advanced waste water treatment process- sand, coal and activated carbon filters, phosphorous, sulphur, nitrogen and heavy metals removal; Assessment, treatment and disposal of solid waste;

Effluent treatment plants; Environmental performance of food industry to comply with ISO-14001 standards

Practical

Determination of temperature, pH, turbidity solids content, BOD and COD of waste water; Determination of ash content of agricultural wastes and determination of un-burnt carbon in ash; Study about briquetting of agricultural residues; Estimation of excess air for better combustion of briquettes; Study of extraction of oil from rice bran; Study on bioconversion of agricultural wastes; Recovery of germ and germ oil from by-products of cereals; Visit to various industries using waste and food by- products.

Theory

Planning of lectures		
S.No.	Topics to be covered in Lecture	Proposed No. of Lectures
1	Types and formation of by-products and waste	2
2	Magnitude of waste generation in different food processing industries;	2
3	Uses of different agricultural by-products from rice mill, sugarcane industry, oil mill etc.;	2
4	Concept, scope and maintenance of waste management and effluent treatment;	2
5	Waste parameters and their importance in waste management-temperature, pH, Oxygen demands (BOD, COD), fat, oil and grease content, metal content	3
6	forms of phosphorous and sulphur in waste waters, microbiology of waste, other ingredients like insecticide, pesticides and fungicides residues	2
7	Waste utilization in various industries, furnaces and boilers run on agricultural wastes and by products,	2
8	briquetting of biomass as fuel, production of charcoal briquette, generation of electricity using surplus biomass, producer gas generation and utilization;	3
9	Waste treatment and disposal:	1
10	Design, construction, operation and management of institutional community and family size biogas plants, vermi- composting;	3
11	Pre-treatment of waste: sedimentation, coagulation, flocculation and floatation;	2
12	Secondary treatments: biological and chemical oxygen demand for different food plant waste– trickling filters, oxidation ditches, activated sludge process, rotating biological contractors, lagoons;	3
13	Tertiary treatments:	1

14	advanced waste water treatment process- sand, coal and activated carbon filters, phosphorous, sulphur, nitrogen and heavy metals removal;	2
15	Assessment, treatment and disposal of solid waste;	2
16	Effluent treatment plants; Environmental performance of food industry to comply with ISO-14001	2
		34

Practical

Planning of Practical		
S.No.	Topics	Proposed No. of Practical
1	Determination of temperature, pH, turbidity solids content, BOD and COD of waste water;	3
2	Determination of ash content of agricultural wastes and determination of un-burnt carbon in ash;	3
3	Study about briquetting of agricultural residues;	2
4	Estimation of excess air for better combustion of briquettes;	2
5	Study of extraction of oil from rice bran;	1
6	Study on bioconversion of agricultural wastes	2
7	Recovery of germ and germ oil from by-products of cereals	2
8	Visit to various industries using waste and food by- products.	2
		17

Suggested Reading

1. Markel I A. 1981. *Managing Livestock Waste*. AVI Publishing Co.
2. Pantastico E C B. 1975. *Post-harvest Physiology, Handling and Utilization of Tropical and Sub-tropical Fruits and Vegetables*. AVI Pub. Co.
3. Shewfelt R L and Prussi S E. 1992. *Post-Harvest Handling - A Systems approach*. Academic Press Inc.
4. USDA 1992. *Agricultural Waste Management Field Hand book*. USDA, Washington DC.
5. Weichmann J. 1987. *Post-Harvest Physiology of Vegetables*. Marcel and Dekker Verlag.
6. Joshi V K and Sharma S K. 2011. *Food Processing Waste Management: Treatment & Utilization Technology*. New India Publishing Agency.
7. Vasso O and Winfried R (Eds.). 2007. *Utilization of By-products and Treatment of Waste in the Food Industry*. Springer Science & Business Media, LLC 233 New York.
8. Prashar A and Bansal P. 2008. *Industrial Safety and Environment*. S.K. Kataria and Sons, New Delhi.
9. Garg S K. 1998. *Environmental Engineering (Vol. II) – Sewage Disposal and Air Pollution Engineering*. Khanna Publishers, New Delhi
10. Bhatia S C. 2001. *Environmental Pollution and Control in Chemical Process Industries*. Khanna Publishers, New Delhi.

SEMESTER – 8 (Elective course)

Sr. No.	Course Name	Course No.	Credit	L	P	T
10.	Floods and Control Measures	SWCE8.12	3(2+1)	2	1	3

Course Content:

Floods- causes of occurrence, flood classification- probable maximum flood, standard project flood, design flood, flood estimation- methods of estimation; Estimation of flood peak- rational method, empirical methods, unit hydrograph method; Statistics in hydrology, flood frequency methods- lognormal, Gumbel's extreme value, log-Pearson type-III distribution; depth-area-duration analysis, flood forecasting; Flood routing- channel routing, Muskingum method, reservoir routing, modified Pul's method; Flood control- history of flood control, structural and non-structural measures of flood control, storage and detention reservoirs, levees, channel improvement; Gully erosion and its control structures- design and implementation; Earthen embankments- functions, classification, hydraulic fill and rolled fill dams, homogeneous, zoned and diaphragm type, foundation requirements, grouting, seepage through dams, flow net and its properties, seepage pressure, seepage line in composite earth embankments, drainage filters, piping and its causes; Design and construction of earthen dam, stability of earthen embankments against failure by tension, overturning, sliding, etc., stability of slopes- analysis of failure by different methods; Planning of flood control projects and their economics

Practical

Determination of flood stage-discharge relationship in a watershed; Determination of flood peak-area relationships; Determination of frequency distribution functions for extreme flood values using Gumbel's method; Determination of confidence limits of the flood peak estimates for Gumbel's extreme value distribution; Determination of frequency distribution functions for extreme flood values using log-Pearson Type-III distribution; Determination of probable maximum flood, standard project flood and spillway design flood; Design of levees for flood control; Designing, planning and costbenefit analysis of a flood control project; Design of earthen dams; Determination of the position of phreatic line in earth dams for various conditions, stability analysis of earthen dams against head water pressure, foundation shear, sudden draw down condition; Stability of slopes of earth dams by friction circle and other methods; Construction of flow net for isotropic and anisotropic media; Computation of seepage by different methods; Determination of settlement of earth dam; Input-output-storage relationships by reservoir routing; Study of reservoir rule curve; Visit to earthen dam and flood control reservoir.

Planning of Lectures		
Sr. No	Topics to be covered in lecture	Proposed No. of Lectures
1.	Floods- causes of occurrence, flood classification- probable maximum flood, standard project flood, design flood.	2
2.	Flood estimation- methods of estimation; Estimation of flood peak- rational method, empirical methods, unit hydrograph method.	4
3.	Statistics in hydrology, flood frequency methods- lognormal, Gumbel's extreme value, log-Pearson type-III distribution.	3
4.	Depth-area-duration analysis, flood forecasting.	2
5.	Flood routing- channel routing, Muskingum method, reservoir	3

	routing, modified Pul's method.	
6.	Flood control- history of flood control.	2
7.	Structural and non-structural measures of flood control, storage and detention reservoirs, levees, channel improvement.	3
8.	Gully erosion and its control structures- design and implementation	3
9.	Earthen embankments- functions, classification, hydraulic fill and rolled fill dams, homogeneous, zoned and diaphragm type, foundation requirements, grouting, seepage through dams, flow net and its properties, seepage pressure, seepage line in composite earth embankments, drainage filters, piping and its causes.	4
10.	Design and construction of earthen dam, stability of earthen embankments against failure by tension, overturning, sliding, etc.,	3
11.	Stability of slopes- analysis of failure by different methods; Planning of flood control projects and their economics.	3
Total		32

Planning of Practical		
Sr. No	Topics to be covered in lecture	No. of Practical
1.	Determination of flood stage-discharge relationship in a watershed	1
2.	Determination of flood peak-area relationships	1
3.	Determination of frequency distribution functions for extreme flood values using Gumbel's method	1
4.	Determination of confidence limits of the flood peak estimates for Gumbel's extreme value distribution	1
5.	Determination of frequency distribution functions for extreme flood values using log-Pearson Type-III distribution	1
6.	Determination of probable maximum flood, standard project flood and spillway design flood	1
7.	Design of levees for flood control; Designing, planning and costbenefit analysis of a flood control project	1
8.	Design of earthen dams; Determination of the position of phreatic line in earth dams for various conditions, stability analysis of earthen dams against head water pressure, foundation shear, sudden draw down condition; Stability of slopes of earth dams by friction circle and other methods	4
9.	Construction of flow net for isotropic and anisotropic media	1
10.	Computation of seepage by different methods	1
11.	Determination of settlement of earth dam; Input-output-storage relationships by reservoir routing	1
12.	Study of reservoir rule curve	1
13.	Visit to earthen dam and flood control reservoir.	1
Total		16

Suggested Reading

1. Michael A M and Ojha T P. 2003. *Principles of Agricultural Engineering*. Volume II. 4th Edition, Jain Brothers, New Delhi.
2. Murthy V V N. 2010. *Land and Water Management Engineering*. 4th Edition, Kalyani Publishers, New Delhi.

3. Suresh R. 2014. *Soil and Water Conservation Engineering*. Standard Publisher Distributors, New Delhi.
4. Mutreja K N. 1990. *Applied Hydrology*. Tata McGraw-Hill Publishing Co., New York, Delhi.
5. Subramanya K. 2008. *Engineering Hydrology*. 3rd Edition, Tata McGraw-Hill Publishing Co., New Delhi.
6. Bureau of Reclamation. 1987. *Design of Small Dams*. US Department of Interior, Washington DC, USA.
7. Arora K R. 2014. *Soil Mechanics and Foundation Engineering (Geotechnical Engineering)*. Standard Publishers Distributors, Delhi.
8. Modi P N. 2010. *Irrigation and Water Power Engineering*. Standard Publishers Distributors, Delhi.
9. Garg S K. 2014. *Soil Mechanics and Foundation Engineering*. Khanna Publishers, Delhi.
10. Garg S K. 2018. *Irrigation Engineering and Hydraulic Structures*. Khanna Publishers, Delhi.
11. Stephens Tim. 2010. *Manual on Small Earth Dams - A Guide to Siting, Design and Construction*. Food and Agriculture Organization of the United Nations, Rome.

SEMESTER – 8 (Elective course)

Sr. No.	Course Name	Course No.	Credit	L	P	T
11	Remote Sensing and GIS Applications	SWCE8.13	3(2+1)	2	1	3

Course Content:

Basic component of remote sensing (RS), advantages and limitations of RS, possible use of RS techniques in assessment and monitoring of land and water resources; Electromagnetic spectrum, energy interactions in the atmosphere and with the Earth's surface; Major atmospheric windows, principal applications of different wavelength regions, typical spectral reflectance curve for vegetation, soil and water; Spectral signatures, different types of sensors and platforms, contrast ratio and possible causes of low contrast, aerial photography; Types of aerial photographs, scale of aerial photographs, planning aerial photography- end lap and side lap, stereoscopic vision, requirements of stereoscopic photographs; Air-photo interpretation- interpretation elements; Photogrammetry- measurements on a single vertical aerial photograph, measurements on a stereo-pair- vertical measurement by the parallax method; Ground control for aerial photography; satellite remote sensing, multispectral scanner whiskbroom and push-broom scanner; Different types of resolutions; analysis of digital data- image restoration; image enhancement; Information extraction, image classification, unsupervised classification, supervised classification, important consideration in the identification of training areas, vegetation indices; Microwave remote sensing, GIS and basic components, different sources of spatial data, basic spatial entities, major components of spatial data; Basic classes of map projections and their properties; Methods of data input into GIS, data editing, spatial data models and structures, attribute data management, integrating data (map overlay) in GIS; Application of remote sensing and GIS for the management of land and water resources.

Practical

Familiarization with remote sensing and GIS hardware; Use of software for image interpretation; Interpretation of aerial photographs and satellite imagery; Basic GIS operations such as image display; Study of various features of GIS software package; Scanning, digitization of maps and data editing; Data base query and map algebra; GIS supported case studies in water resources management.

Planning of lectures		
S.No.	Topics to be covered in Lecture	Proposed No. of Lectures
1	Basic component of remote sensing (RS), advantages and limitations of RS,	1
2	Possible use of RS techniques in assessment and monitoring of land and water resources;	1
3	Electromagnetic spectrum, energy interactions in the atmosphere and with the Earth's surface;	2
4	Major atmospheric windows, principal applications of different wavelength regions, typical spectral reflectance curve for vegetation, soil and water; Spectral signatures,	2
5	Different types of sensors and platforms, contrast ratio and possible causes of low contrast,	2
6	Aerial photography; Types of aerial photographs, scale of aerial photographs, planning aerial photography- end lap and side lap, stereoscopic vision, requirements of stereoscopic photographs;	2
7	Air-photo interpretation- interpretation elements;	2
8	Photogrammetry- measurements on a single vertical aerial photograph, measurements on a stereo-pair- vertical measurement by the parallax method; Ground control for aerial photography;	2
9	Satellite remote sensing, multispectral scanner whiskbroom and push-broom scanner;	2
10	Different types of resolutions;	1
11	Analysis of digital data- image restoration; image enhancement;	2
12	Information extraction, image classification, unsupervised classification, supervised classification, important consideration in the identification of training areas,	2
13	Vegetation indices;	2
14	Microwave remote sensing,	2
15	GIS and basic components,	1
16	Different sources of spatial data, basic spatial entities, major components of spatial data;	2
17	Basic classes of map projections and their properties;	1
18	Methods of data input into GIS, data editing,	1
19	Spatial data models and structures, attribute data management, integrating data (map overlay) in GIS;	1
20	Application of remote sensing and GIS for the management of land and water resources.	1
	Total	32

Practicals

S.No.	Topic	No. of Practicals
1	Familiarization with remote sensing and GIS hardware;	1
2	Use of software for image interpretation;	1
3	Interpretation of aerial photographs and satellite imagery;	2
4	Basic GIS operations such as image display;	1
5	Study of various features of GIS software package;	3
6	Scanning, digitization of maps and data editing;	3
7	Data base query and map algebra;	2
8	GIS supported case studies in water resources management.	3
	Total	16

Suggested Reading

1. Reddy A M. 2006. *Textbook of Remote Sensing and Geographical Information Systems*. BS Publications, Hyderabad.
2. Elangovan K. 2006. *GIS Fundamentals Applications and Implementations*. New India Publication Agency, New Delhi.
3. George J. 2005. *Fundamentals of Remote Sensing*. 2nd Edition. Universities Press (India) Private Limited, Hyderabad.
4. Jensen J R. 2013. *Remote Sensing of the Environment : An Earth Resource Perspective*. Pearson Education Limited, UK.
5. Lillesand T, Kiefer R W and Chipman J. 2015. *Remote Sensing and Image Interpretation*. 7th Edition, John Wiley and Sons Singapore Pvt. Ltd., Singapore.
6. Sabins F F. 2007. *Remote Sensing : Principles and Interpretation*. Third Edition, Waveland Press Inc., Illinois, USA.
7. Sahu K C. 2008. *Text Book of Remote Sensing and Geographic Information Systems*. Atlantic Publishers and Distributors (P) Ltd., New Delhi.
8. Shultz G A and Engman E T. 2000. *Remote Sensing in Hydrology and Water Management*. Springer, New York.

SEMESTER – 8 (Electives)

Sr. No.	Course Name	Course No.	Credit	L	P	T
12	Information Technology for Land and Water Management	SWCE8.14	3(2+1)	2	1	3

Objective

To enable the students to understand the application of IT natural resources management and design and application of decision support system and expert systems for NRM

Theory

Concept of Information Technology (IT) and its application potential, role of IT in natural resources management; Existing system of information generation and organizations involved in the field of land and water management; Application and production of multimedia, internet application tools and web technology, networking system of information, problems and prospects of new information and communication technology; Development of database concept for effective natural resources management; Application of remote sensing, geographic information system (GIS) and GPS; Rational data base management system, object

oriented approaches; Information system, decision support systems and expert systems; Agricultural information management systems- use of mathematical models and programs; Application of decision support systems, multi sensor data loggers and overview of software packages in natural resource management; Video-conferencing of scientific information

Practical

Multimedia production; Internet applications: E-mail, voice mail, web tools and technologies; Handling and maintenance of new information technologies and exploiting their potentials; Exercises on database management using database and spreadsheet programs; Usage of remote sensing, GIS and GPS survey in information generation and processing; Exercises on running computer software packages dealing with water balance, crop production, land development, land and water allocation, watershed analysis etc; Exercises on simple decision support and expert systems for management of natural resources; Multimedia production using different softwares; Exercises on development of information system on selected theme(s); Video-conferencing of scientific information.

Theory

Planning of lectures		
S.No.	Topics to be covered in Lecture	Proposed No. of Lectures
1	Concept of Information Technology (IT) and its application potential, role of IT in natural resources management	3
2	Existing system of information generation and organizations involved in the field of land and water management	3
3	Application and production of multimedia, internet application tools and web technology, networking system of information, problems and prospects of new information and communication technology	6
4	Development of database concept for effective natural resources management	3
5	Application of remote sensing, geographic information system (GIS) and GPS	2
6	Rational data base management system, object oriented approaches	3
7	Information system, decision support systems and expert systems	3
8	Agricultural information management systems- use of mathematical models and programs	3
9	Application of decision support systems, multi sensor data loggers and overview of software packages in natural resource management	4
10	Video-conferencing of scientific information	2
		32

Practical

Planning of Practical		
S.No.	Topics	Proposed No. of Practical
1	Multimedia production	1
2	Internet applications: E-mail, voice mail, web tools and technologies	1
3	Handling and maintenance of new information technologies and exploiting their potentials	1
4	Exercises on database management using database and spreadsheet	2

	programs	
5	Usage of remote sensing, GIS and GPS survey in information generation and processing	2
6	Exercises on running computer software packages dealing with water balance, crop production, land development, land and water allocation, watershed analysis etc	4
7	Exercises on simple decision support and expert systems for management of natural resources	2
8	Multimedia production using different softwares	1
9	Exercises on development of information system on selected theme(s); Video-conferencing of scientific information	2
		16

Suggested Reading

1. FAO. 2013. *Climate-Smart Agriculture- Source Book*. FAO, Rome.
2. Loucks D P and Beek E V. 2005. *Water Resources Systems Planning and Management - An Introduction to Methods, Models and Applications*. UNESCO, Paris.
3. De D and Basavaprabhu J (Eds.). 2010. *Communication Support for Sustainable Development*. Ganga Kaveri Publishing House, Varanasi.
4. FAO. 1998. *Land and Water Resources Information Systems*. FAO Land and Water Bulletin 7, Rome.
5. Bian F and Xie Y (Eds.). 2015. *Geo-Informatics in Resource Management and Sustainable Ecosystem*. Springer, New York.
6. ICFAI Business School (IBS). 2012. *Information Technology and Systems*. IBS Centre for Management Research, Hyderabad.
7. Malliva R and Thomas M. 2012. *Arid Lands Water Evaluation and Management*.
8. Sarvanan R. 2011. *Information and Communication Technology for Agriculture and Rural Development*. New India Publishing Agency, New Delhi.
9. Soam S K, Sreekanth P D and Rao N H (Eds.). 2013. *Geospatial Technologies for Natural Resources Management*. New India Publishing Agency, Delhi.

SEMESTER – 8 (Elective course)

Sr. No.	Course Name	Course No.	Credit	L	P	T
13	Wasteland Development	SWCE8.15	3(2+1)	2	1	3

Course Content:

Land degradation- concept, classification, arid, semiarid, humid and sub-humid regions, Troll's climatic classification, denuded range land and marginal lands; Wastelands- factors causing waste lands, classification and mapping of wastelands, planning of wasteland development-constraints, agro-climatic conditions, development options, contingency plans; Conservation structures- gully stabilization, ravine rehabilitation, sand dune stabilization, water harvesting and recycling methods; Afforestation- agro-horti-forestry-silvipasture methods, forage and fuel crops, socioeconomic constraints; Shifting cultivation, optimal land use options; Wasteland development- hills, semi-arid, coastal areas, water scarce areas, reclamation of waterlogged and salt-affected lands; Mine spoils impact, land degradation and reclamation and rehabilitation, slope stabilization and mine environment management; Micro-irrigation in wastelands development; Sustainable wasteland development- drought situations, socio-economic

perspectives; Participatory approach in wasteland management; Preparation of proposal for wasteland development and benefit-cost analysis

Practical

Mapping and classification of wastelands; Identification of factors causing wastelands; Estimation of vegetation density and classification; Planning and design of engineering measures for reclamation of wastelands; Design and estimation of different soil and water conservation structures under arid, semiarid and humid conditions; Planning and design of micro-irrigation in wasteland development; Study on utilization of fly-ash in hydraulic structures; Study on mine spoil areas by plantation; Study on mine spoil areas by back filling of fly-ash; Study on environmental impact assessment (EIA) of mine spoil areas; Cost estimation of the various wasteland development measures; Study on PRA exercise on wasteland management; Preparation of DPR of wasteland development projects; Visit to wasteland development project sites.

Planning of Lectures		
Sr. No	Topics to be covered in lecture	Proposed No. of Lectures
1.	Land degradation- concept, classification, arid, semiarid, humid and sub-humid regions,	2
2.	Troll's climatic classification, denuded range land and marginal lands;	2
3.	Wastelands- factors causing waste lands, classification and mapping of wastelands	2
4.	Planning of wasteland development- constraints, agro-climatic conditions, development options, contingency plans	3
5.	Conservation structures- gully stabilization, ravine rehabilitation	3
6.	Sand dune stabilization, water harvesting and recycling methods	2
7.	Afforestation- agro-horti-forestry-silvipasture methods, forage and fuel crops, socioeconomic constraints	2
8.	Shifting cultivation, optimal land use options	2
9.	Wasteland development- hills, semi-arid, coastal areas, water scarce areas, reclamation of waterlogged and salt-affected lands	3
10.	Mine spoils impact, land degradation and reclamation and rehabilitation, slope stabilization and mine environment management	3
11.	Micro-irrigation in wastelands development	2
12.	Sustainable wasteland development- drought situations, socio-economic perspectives	3
13.	Participatory approach in wasteland management	2
14.	Preparation of proposal for wasteland development and benefit-cost analysis	2
Total		33

Planning of Practical		
Sr. No	Topics to be covered in lecture	No. of Practical
1.	Mapping and classification of wastelands	1
2.	Identification of factors causing wastelands	1

3.	Estimation of vegetation density and classification	1
4.	Planning and design of engineering measures for reclamation of wastelands	1
5.	Design and estimation of different soil and water conservation structures under arid, semiarid and humid conditions	2
6.	Planning and design of micro-irrigation in wasteland development	1
7.	Study on utilization of fly-ash in hydraulic structures	1
8.	Study on mine spoil areas by plantation	1
9.	Study on mine spoil areas by back filling of fly-ash	1
10.	Study on environmental impact assessment (EIA) of mine spoil areas	1
11.	Cost estimation of the various wasteland development measures	2
12.	Study on PRA exercise on wasteland management	1
13.	Preparation of DPR of wasteland development projects	1
14.	Visit to wasteland development project sites.	1
Total		16

Suggested Reading

1. Abrol I P and Dhruvanarayana V V. 1998. *Technologies for Wasteland Development*. ICAR, New Delhi.
2. Ambast S K, Gupta S K and Singh G (Eds.). 2007. *Agricultural Land Drainage – Reclamation of Waterlogged Saline Lands*. Central Soil Salinity Research Institute, Karnal, Haryana.
3. Yadav H R. 2013. *Management of Wastelands*. Concept Publishing Company. New Delhi.
4. Karthikeyan C, Thangaraja K, Fernandez C C and Chandrakandon K. 2009. *Dryland Agriculture and Wasteland Management*. Atlantic Publishers and Distributors Pvt. Ltd., New Delhi.
5. Lal R and Stewart B A (Ed.). 2015. *Soil Management of Smallholder Agriculture*. Volume 21 of Advances in Soil Science. CRC Press, USA.
6. Malliva R and Missimer T. 2012. *Arid Lands Water Evaluation and Management*. Springer Heidelberg, New York.
7. Swaminathan M S. 2010. *Science and Integrated Rural Development*. Concept Publishing Company (P) Ltd., Delhi.
8. Pachauri R K and Sridharan P V (Eds.). 2003. *Looking Back to Think Ahead Green India 2047*. TERI, New Delhi.
9. Virmani S M (Ed.). 2010. *Degraded and Wastelands of India: Status and Spatial Distribution*. ICAR, New Delhi.

SEMESTER – 8 (Elective course)

Sr. No.	Course Name	Course No.	Credit	L	P	T
14.	Minor Irrigation and Command Area Development	IDE8.16	3(2+1)	2	1	3

Objective

To enable the students to importance of command area development programmes in irrigation projects and to plan, design, execute and evaluate on-farm development works

Theory

Major, medium and minor irrigation projects, factors affecting performance of irrigation

projects; Types of minor irrigation systems in India, surface water and groundwater projects; Lift irrigation systems: feasibility, type of pumping stations and their site selection, design of lift irrigation systems; Tank irrigation: grouping of tanks, storage capacity, supply works and sluices; Earthen dams: components, types, methods of construction, causes of failure of earthen dams, seepage control in earthen dams;

Command area development (CAD) programme- components, need, scope, and development approaches, historical perspective, command area development authorities- objectives, functions and responsibilities; On farm development works, design of lined and un-lined field channel and its cost estimation; Farmers' participation in command area development, PIM, water user's association; Reclamation works, cross drainage works; Use of remote sensing techniques for CAD works; Rotational irrigation system, Warabandi, pre-requisites for warabandi; Conjunctive use of water, optimum utilization of water; Water productivity: concepts and measures for enhancing water productivity

Practical

Preparation of command area development layout plan; Irrigation water requirement of crops of command area; Preparation of irrigation schedules; Planning and layout of water conveyance system; Design of surplus weir of tanks; Determination of storage capacity of tanks; Design of intake pipe and pump house; Planning and design of OFD works; Cost estimation of OFD work; Study of cross- drainage works; Design and cost estimation of earthen dams for minor irrigation project; Estimation of seepage in field channels; Visit to a minor irrigation project; Visit to a command area and study of OFD works; Study of reclamation of waterlogged areas inside command area.

Theory

Planning of lectures		
S.No.	Topics to be covered in Lecture	Proposed No. of Lectures
1	Major, medium and minor irrigation projects, factors affecting performance of irrigation projects	2
2	Types of minor irrigation systems in India, surface water and groundwater projects	1
3	Lift irrigation systems: feasibility, type of pumping stations and their site selection, design of lift irrigation systems	2
4	Tank irrigation: grouping of tanks, storage capacity, supply works and sluices	2
5	Earthen dams: components, types, methods of construction, causes of failure of earthen dams, seepage control in earthen dams	3
6	Command area development (CAD) programme- components, need, scope, and development approaches, historical perspective, command area development authorities- objectives, functions and responsibilities	4
7	On farm development works, design of lined and un-lined field channel and its cost estimation	4
8	Farmers' participation in command area development, PIM, water user's association	2
9	Reclamation works, cross drainage works	2
10	Use of remote sensing techniques for CAD works	2

11	Rotational irrigation system, Warabandi, pre-requisites for warabandi	3
12	Conjunctive use of water, optimum utilization of water	2
13	Water productivity: concepts and measures for enhancing water productivity	3
		32

Planning of Practical		
S.No.	Topics	Proposed No. of Practical
1	Preparation of command area development layout plan	1
2	Irrigation water requirement of crops of command area	1
3	Preparation of irrigation schedules	1
4	Planning and layout of water conveyance system	1
5	Design of surplus weir of tanks	1
6	Determination of storage capacity of tanks	1
7	Design of intake pipe and pump house	1
8	Planning and design of OFD works	1
9	Cost estimation of OFD work	1
10	Study of cross drainage works	1
11	Design and cost estimation of earthen dams for minor irrigation project	2
12	Estimation of seepage in field channels	1
13	Visit to a minor irrigation project	1
14	Visit to a command area and study of OFD works	1
15	Study of reclamation of waterlogged areas inside command area	1
		16

Suggested Reading

1. Arora K R. 2001. *Irrigation, Water Power and Water Resources Engineering*. Standard Publishers Distributors, Delhi.
2. Garg S K. 2014. *Irrigation Engineering and Hydraulic Structures*. Khanna Publishers, New Delhi.
3. Michael A M. 2012. *Irrigation: Theory and Practice*. Vikas Publishing House New Delhi.
4. Sahasrabudhe S R. 2011. *Irrigation Engineering and Hydraulic structures*. SK Kataria & Sons, Reprint 2015.
5. Reddi G H S and Reddy T Y. 2005. *Efficient use of Irrigation Water*. Kalyani Publishers, Ludhiana.

SEMESTER – 8 (Elective course)

Sr. No.	Course Name	Course No.	Credit	L	P	T
15	Management of Canal Irrigation System	IDE8.17	3(2+1)	2	1	3

Objective

To enable the students to analyse water requirement and availability in a canal command, to take up design of lined and unlined canals and enable to control of losses of water in canal commands and for design and layout of different canal outlet structures

Theory

Typical network of canal irrigation system and its physical components; Canal classifications based on source of water, financial output, purpose, discharge and alignment; Canal alignment: general considerations; Different parts of canal sections, performance indicators for canal irrigation system evaluation; Estimation of water requirements for canal command areas and determination of canal capacity; Base period, water duty and delta, relationship between base period, duty and delta; factors affecting duty and method to improve duty; Silt theory: Kennedy's theory, design of channels by Kennedy's theory, Lacey's regime theory and basic regime equations, design of channels by Lacey's theory; Maintenance of unlined irrigation canals, measurement of discharge in canals; Rostering (canal running schedule) and warabandi, rotational irrigation, pre-requisite of warabandi; Necessity of canal lining: advantages and disadvantages, types of canal lining and desirable characteristics for the suitability of lining materials, design of lined canals; Functions of distributary head and cross regulators; Canal falls, their necessity and factors affecting canal fall, types of canal falls; Sources of surplus water in canals and types of canal escapes; Requirements of a good canal outlet and types of outlet; Participatory irrigation management (PIM), water user's association: necessity, structure, function and duties

Practical

Estimation of water requirement of canal commands; Determination of canal capacity; Layout of canal alignments on topographic maps; Drawing of canal sections in cutting; Design of canal by full banking and partial cutting; Determination of longitudinal section (L-section) of canals; Design of irrigation canals based on silt theories (unlined canal); Design of lined canals; Formulation of warabandi system in canal command areas; Study of various types of canal outlet; Study of various types of canal regulators; Study of canal escapes; Study of various types of canal falls; Visit to a canal off taking site; Visit to a canal command area; Visit and discussion with functionaries of water user association.

Theory

Planning of lectures		
S.No.	Topics to be covered in Lecture	Proposed No. of Lectures
1	Typical network of canal irrigation system and its physical components	2
2	Canal classifications based on source of water, financial output, purpose, discharge and alignment	2
3	Canal alignment: general considerations	1
4	Different parts of canal sections, performance indicators for canal irrigation system evaluation	3
5	Estimation of water requirements for canal command areas and determination of canal capacity	2
6	Base period, water duty and delta, relationship between base period, duty and delta; factors affecting duty and method to improve duty	2
7	Silt theory: Kennedy's theory, design of channels by Kennedy's theory, Lacey's regime theory and basic regime equations, design of channels by Lacey's theory	4
8	Maintenance of unlined irrigation canals, measurement of discharge in canals	2
9	Rostering (canal running schedule) and warabandi, rotational irrigation, pre-requisite of warabandi	2
10	Necessity of canal lining: advantages and disadvantages, types of canal lining and desirable characteristics for the suitability of lining materials,	3

	design of lined canals	
11	Functions of distributary head and cross regulators	2
12	Canal falls, their necessity and factors affecting canal fall, types of canal falls	2
13	Sources of surplus water in canals and types of canal escapes	2
14	Requirements of a good canal outlet and types of outlet	1
15	Participatory irrigation management (PIM), water user's association: necessity, structure, function and duties	2
		32

Practical

Planning of Practical		
S.No.	Topics	Proposed No. of Practical
1	Estimation of water requirement of canal commands	1
2	Determination of canal capacity	1
3	Layout of canal alignments on topographic maps	1
4	Drawing of canal sections in cutting	1
5	Design of canal by full banking and partial cutting	1
6	Determination of longitudinal section (L-section) of canals	1
7	Design of irrigation canals based on silt theories (unlined canal)	1
8	Design of lined canals	1
9	Formulation of warabandi system in canal command areas	1
10	Study of various types of canal outlet	1
11	Study of various types of canal regulators	1
12	Study of canal escapes	1
13	Study of various types of canal falls	1
14	Visit to a canal off taking site	1
15	Visit to a canal command area	1
16	Visit and discussion with functionaries of water user association	1
		16

Suggested Reading

1. Arora K R. 2001. *Irrigation, Water Power and Water Resources Engineering*. Standard Publishers Distributors, Delhi.
2. Garg S K. 2014. *Irrigation Engineering and Hydraulic Structures*. Khanna Publishers New Delhi.
3. Sahasrabudhe S R. 2011. *Irrigation Engineering and Hydraulic structures*. S K Kataria & Sons Reprint 2015.

SEMESTER – 8 (Elective course)

Sr. No.	Course Name	Course No.	Credit	L	P	T
16.	Water Quality and Management Measures	IDE8.18	3(2+1)	2	1	3

Theory:

Natural factors affecting quality of surface water and groundwater, sources and pollution of groundwater; Water quality objectives in relation to domestic, industrial and agricultural activities, drinking water quality standards, irrigation water quality classification as per USSL and AICRP criteria; Point and non-point water pollution sources; Water contamination due to inorganic and organic compounds, water contamination related to agricultural chemicals, food industry, hydrocarbon and synthetic organic compounds; Arsenic and fluoride contamination in groundwater and remedial measures; Water decontamination technologies; Cultural and management practices for using poor quality water for irrigation.

Practical

Water quality analysis and classification according to USSL and AICRP criteria; Soil chemical analysis and estimation of lime and gypsum requirements; Study of salinity development under shallow and deep water table conditions; Study of saline water ingress in coastal areas; Study of contamination movement and transport in soil profile; Study of turbidity of water through turbidity meter; Study of different water decontamination techniques; Study of different cultural and management practices for using poor quality water for irrigation; Visit to a water treatment plant; Visit to a water quality laboratory; Field visit to industrial effluent disposal sites.

Theory:

Planning of lectures		
S.No.	Topics to be covered in Lecture	Proposed No. of Lectures
1	Natural factors affecting quality of surface water and groundwater,	1
2	Sources and pollution of groundwater;	3
3	Water quality objectives in relation to domestic, industrial and agricultural activities,	4
4	Drinking water quality standards,	2
5	Irrigation water quality classification as per USSL and AICRP criteria;	4
6	Point and non-point water pollution sources;	4
7	Water contamination due to inorganic and organic compounds,	2
8	Water contamination related to agricultural chemicals, food industry, hydrocarbon and synthetic organic compounds;	4
9	Arsenic and fluoride contamination in groundwater and remedial measures;	2
10	Water decontamination technologies;	3
11	Cultural and management practices for using poor quality water for irrigation.	3
	Total	32

Practical

Practical		
S.No.	Topic	No. of Practicals
1	Water quality analysis and classification according to USSL and AICRP criteria;	2
2	Soil chemical analysis and estimation of lime and gypsum requirements;	2
3	Study of salinity development under shallow and deep water table conditions;	1

4	Study of saline water ingress in coastal areas;	2
5	Study of contamination movement and transport in soil profile	1
6	; Study of turbidity of water through turbidity meter;	1
7	Study of different water decontamination techniques;	2
8	Study of different cultural and management practices for using poor quality water for irrigation;	2
9	Visit to a water treatment plant;	1
10	Visit to a water quality laboratory;	1
11	Field visit to industrial effluent disposal sites	1
	Total	16

Suggested Reading

1. FAO. 1996. *Control of water pollution from agriculture - FAO irrigation and drainage paper 55*.
2. Gray N F. 2010. *Water Technology*. CRC Press.
3. Hussain S K. 1986. *Text Book of Water Supply and Sanitary Engineering*. Oxford & IBH Publishing Co. New Delhi.
4. Manahan S E. 2009. *Fundamentals of Environmental Chemistry*. CRC Press, New York.
5. McGauhey P H. 1968. *Engineering Management of water quality*. McGraw Hill Book Company, New York.
6. Minhas P S and Tyagi N K. 1998. *Guidelines for irrigation with saline and alkali waters*. Bull. No, 1/98, CSSRI, Karnal, p. :36
7. Punmia B C and Lal P B B. 1981. *Irrigation and water power engineering*. Standard Publishers Distributors, Delhi.

SEMESTER – 8 (Elective course)

Sr. No.	Course Name	Course No.	Credit	L	P	T
17.	Landscape Irrigation Design and Management	IDE8.19	3(2+1)	2	1	3

Objective

To enable the students to know about the different conventional and modern methods of landscape irrigation, various types of landscapes and their suitability with regard to different irrigation methods, design the modern landscape irrigation systems, automation of the landscape irrigation system and irrigation scheduling with proper methods of irrigation for different landscapes

Theory

Conventional method of landscape irrigation- hose irrigation system, and portable sprinkler with hose pipes; Modern methods of landscape irrigation- pop-up sprinklers, spray pop-up sprinkler, shrub adopter, drip irrigation and bubblers; Merits and demerits of conventional and modern irrigation systems; Types of landscapes and suitability of different irrigation methods, water requirement for different landscapes; Segments of landscape irrigation systems, main components of modern landscape irrigation systems and their selection criteria; Types of pipes, pressure ratings, sizing and selection criteria; Automation system for landscape irrigation- main components, types of controllers and their application; Use of sensors for irrigation automation and use of IOT in landscape irrigation; Use of AutoCAD in irrigation design; Design of modern landscape irrigation systems, operation and maintenance of landscape irrigation systems

Practical

Study of irrigation equipment for landscapes; Design and installation of irrigation system for landscape; Determination of water requirement; Determination of power requirement, pump selection; Irrigation scheduling of landscapes; Study of irrigation controllers and other equipment; Use of AutoCAD in irrigation design; Study of blocks & symbols, head layout, zoning and valves layout, pipe sizing, pressure calculations, etc.; Study of various types of sensors for irrigation automation; Study of IOT in landscaping irrigation; Visit to landscape irrigation system and its evaluation.

Planning of lectures		
S.No.	Topics to be covered in Lecture	Proposed No. of Lectures
1	Conventional method of landscape irrigation- hose irrigation system, and portable sprinkler with hose pipes	3
2	Modern methods of landscape irrigation- pop-up sprinklers, spray pop-up sprinkler, shrub adopter, drip irrigation and bubblers	6
3	Merits and demerits of conventional and modern irrigation systems	2
4	Types of landscapes and suitability of different irrigation methods, water requirement for different landscapes	4
5	Segments of landscape irrigation systems, main components of modern landscape irrigation systems and their selection criteria	3
6	Types of pipes, pressure ratings, sizing and selection criteria	2
7	Automation system for landscape irrigation- main components, types of controllers and their application	4
8	Use of sensors for irrigation automation and use of IOT in landscape irrigation	3
9	Use of AutoCAD in irrigation design	3
10	Design of modern landscape irrigation systems, operation and maintenance of landscape irrigation systems	2
		32

Practical

Planning of Practical		
S.No.	Topics	Proposed No. of Practical
1	Study of irrigation equipment for landscapes	1
2	Design and installation of irrigation system for landscape	2
3	Determination of water requirement	1
4	Determination of power requirement, pump selection	1
5	Irrigation scheduling of landscapes	1
6	Study of irrigation controllers and other equipment	2
7	Use of AutoCAD in irrigation design	2
8	Study of blocks & symbols, head layout, zoning and valves layout, pipe sizing, pressure calculations, etc.	2
9	Study of various types of sensors for irrigation automation	1
10	Study of IOT in landscaping irrigation	2

11	Visit to landscape irrigation system and its evaluation	1
		16

Suggested Reading

1. Michael A M. 2012. *Irrigation: Theory and Practice*. Vikas Publishing House, New Delhi.
2. Singh N P. 2010. *Landscape Irrigation and Floriculture Terminology*. Bangalore.
3. Smith S W. 1996. *Landscape Irrigation: Design and Management*. John Wiley and Sons, Inc., New York, United States.

SEMESTER – 8 (Elective course)

Sr. No.	Course Name	Course No.	Credit	L	P	T
18.	Application of Plastics in Agriculture	AS8.20	3(2+1)	2	1	3

Objective

To enable the students to understand the applications in moisture conservation, canal and pond lining, use of plastic pipes in irrigation and drainage; know about soil solarisation, mulching, covering materials in green houses, shade houses, poly houses, surface covered cultivation, plastic fencing, nets for insects, birds etc. and in food grain structures, packaging materials, aquaculture, etc.

Theory

Introduction of plasticulture- types and quality of plastics used in soil and water conservation, production agriculture and post-harvest management, present status and future prospective of plasticulture in India, quality control measures; Water management- use of plastics in in-situ moisture conservation and rain water harvesting; Plastic film lining in canal, pond and reservoir, plastic pipes for irrigation water management, borewell casing and subsurface drainage, drip and sprinkler irrigation systems, use of polymers in control of percolation losses in fields; Soil conditioning- soil solarisation, effects of different colour plastic mulching in surface covered cultivation; Nursery management- use of plastics in nursery raising, nursery bags, trays, etc.; Controlled environmental cultivation- plastics as cladding material, green / poly / shade net houses, wind breaks, poly tunnels and crop covers; Plastic nets for crop protection- anti insect nets, bird protection nets, plastic fencing;

Plastics in drying, preservation, handling and storage of agricultural produce, innovative plastic packaging solutions for processed food products, Plastic CAP covers for storage of food grains in open; Use of plastics as alternate material for manufacturing farm equipment and machinery; Plastics for aquacultural engineering and animal husbandry- animal shelters, vermi-beds and inland fisheries; Silage film technique for fodder preservation; Agencies involved in the promotion of plasticulture in agriculture at national and state level. Human resource development in plasticulture applications

Practical

Design, estimation and laying of plastic films in lining of canal, reservoir and water

harvesting ponds; Study of plastic components of drip and sprinkler irrigation systems, laying and flushing of laterals; Study of components of subsurface drainage system; Study of different colour plastic mulch laying; Design, estimation and installation of green, poly and shade net houses, low tunnels, etc; Study on CAP device for food grain storage; Study of innovative packaging solutions - leno bags, crates, bins, boxes, vacuum packing, unit packaging, CAS and MAP; Study on use of plastics in nursery, plant protection, inland fisheries, animal shelters; Preparation of vermi-bed and silage film for fodder preservation; Study of plastic parts in making farm machinery; Visits to nearby manufacturing units/ dealers of PVC pipes, drip and sprinkler irrigation systems, greenhouse/ poly-house/ shade-house/ net- house etc; Visits to farmers' fields with these installations.

Planning of lectures		
Sr. No.	Topics to be covered in Lecture	Proposed No. of Lectures
1	Introduction of plasticulture- types and quality of plastics used in soil and water conservation, production agriculture and post-harvest management, present status and future prospective of plasticulture in India, quality control measures	4
2	Water management- use of plastics in in-situ moisture conservation and rain water harvesting; Plastic film lining in canal, pond and reservoir, plastic pipes for irrigation water management, bore-well casing and subsurface drainage, drip and sprinkler irrigation systems, use of polymers in control of percolation losses in fields	4
3	Soil conditioning- soil solarisation, effects of different colour plastic mulching in surface covered cultivation;	3
4	Nursery management- use of plastics in nursery raising, nursery bags, trays, etc.; Controlled environmental cultivation- plastics as cladding material, green / poly / shade net houses, wind breaks, poly tunnels and crop covers;	4
5	Plastic nets for crop protection- anti insect nets, bird protection nets, plastic fencing;	3
6	Plastics in drying, preservation, handling and storage of agricultural produce, innovative plastic packaging solutions for processed food products	4
7	Plastic CAP covers for storage of food grains in open; Use of plastics as alternate material for manufacturing farm equipment and machinery;	3
8	Plastics for aquacultural engineering and animal husbandry- animal shelters, vermi-beds and inland fisheries; Silage film technique for fodder preservation	3
9	Agencies involved in the promotion of plasticulture in agriculture at national and state level. Human resource development in plasticulture applications	4
Total		32
Practical		
Sr. No.	Topic	No. of

		Practical
1	Design, estimation and laying of plastic films in lining of canal, reservoir and water harvesting ponds	3
2	Study of plastic components of drip and sprinkler irrigation systems, laying and flushing of laterals	2
3	Study of components of subsurface drainage system; Study of different colour plastic mulch laying	1
4	Design, estimation and installation of green, poly and shade net houses, low tunnels, etc	1
5	Study on CAP device for food grain storage	1
6	Study of innovative packaging solutions - leno bags, crates, bins, boxes, vacuum packing, unit packaging, CAS and MAP	2
7	Study on use of plastics in nursery, plant protection, inland fisheries, animal shelters; Preparation of vermi-bed and silage film for fodder preservation	2
8	Study of plastic parts in making farm machinery; Visits to nearby manufacturing units/ dealers of PVC pipes, drip and sprinkler irrigation systems, greenhouse/ poly-house/ shade-house/ net- house etc	2
9	Visits to farmers' fields with these installations	2
	Total	16

Suggested Reading

1. Singh Brahma, Singh B, Sabir N and Hasan M. 2014. *Advances in Protected Cultivation*. New India Publishing Agency, New Delhi.
2. Brown R P. 2004. *Polymers in Agriculture and Horticulture*. RAPRA Review Reports : Vol. 15, No. 2, RAPRA Technology Limited, U.K.
3. Central Pollution Control Board. 2012. *Material on Plastic Waste Management*. Parivesh Bhawan, East Arjun Nagar, Delhi.
4. Charles A. Harper. 2006. *Handbook of Plastics Technologies*. The Complete Guide to Properties and Performance. McGraw-Hill, New Delhi.
5. Dubois. 1978. *Plastics in Agriculture*. Applied Science Publishers Limited, Essex, England.
6. Chanda M and Roy S K. 2008. *Plastics Fundamentals, Properties, and Testing*. CRC Press.
7. Ojha T P and Michael A M. 2012. *Principles of Agricultural Engineering - I*. Jain Brothers, Karol Bagh, New Delhi.
8. Pandey P H. 2014. *Principles and Practices of Agricultural Structures and Environmental Control*. Kalyani Publishers, Ludhiana, India.
9. Shankar A N. 2014. *Integrated Horticulture Development in Eastern Himalayas*. Plasticulture in Agri-Horticulture Systems, 241-247.
10. Srivastava R K, Maheswari R C, Ojha T P and Alam A. 1988. *Plastics in Agriculture*. Jain Brothers, Karol Bagh, New Delhi.

SEMESTER – 8 (Elective course)

Sr. No.	Course Name	Course No.	Credit	L	P	T
19.	Precision Farming Techniques for Protected Cultivation	AS8.21	3(2+1)	2	1	3

Objective

To enable the students to design and construction of green houses in different agro-climatic zones, greenhouse cooling and heating systems, environmental parameter and control, ventilation systems, to assess different root media, micro-irrigation, fertigation, planting techniques in green house cultivation and to know about hydroponics, post-harvest management, pest management and economic aspects of a green house

Theory

Protected cultivation: introduction, history, origin, development, national and international scenario;

Types of green houses, components of green house, cladding materials, plant environment interactions, principles of limiting factors, solar radiation and transpiration, greenhouse effect, light, temperature, relative humidity, carbon dioxide enrichment; Design and construction of greenhouses- site selection, orientation, design, construction, design for ventilation requirement using exhaust fan system, selection of equipment; Greenhouse cooling system- methods, ventilation with roof and side ventilators, evaporative cooling, different shading materials, fogging, combined fogging and fan-pad cooling system, design of cooling system, maintenance of cooling and ventilation systems, pad care, etc.; Greenhouse heating- components, methods, design of heating system; Root media- types, soil and soilless media, composition, estimation, preparation and disinfection, bed preparation;

Planting techniques in green house cultivation; Irrigation in greenhouse and net house- water quality, types of irrigation system, components, design, installation and material requirement; Fogging system for greenhouses and net houses- introduction, benefits, design, installation and material requirement; Maintenance of irrigation and fogging systems

Fertilization- nutrient deficiency symptoms and functions of essential nutrient elements, principles of selection of proper application of fertilizers, fertilizer scheduling, rate of application of fertilizers, methods, automated fertilizer application;

Greenhouse climate measurement, control and management; Insect and disease management in greenhouse and net houses; Selection of crops for greenhouse cultivation, major crops in greenhouse- irrigation requirement, fertilizer management, cultivation, harvesting and post-harvest techniques; Economic analysis

Practical

Estimation of material requirement for construction of greenhouse; Determination of fertilization schedule and rate of application for various crops; Estimation of material requirement for preparation of root media; Root media preparation, bed preparation and disinfections; Study of different planting techniques; Design and installation of irrigation system; Design and installation of fogging system; Study of different greenhouse environment control instruments; Study of operation, maintenance and fault detection in irrigation system; Study of operation, maintenance and fault detection in fogging system; Economic analysis of greenhouses and net houses; Visit to greenhouses.

Planning of lectures		
Sr. No.	Topics to be covered in Lecture	Proposed No. of Lectures
1	Protected cultivation: introduction, history, origin, development, national and international scenario	2
2	Types of green houses, components of green house, cladding materials, plant environment interactions, principles of limiting factors, solar radiation and transpiration, greenhouse effect, light, temperature, relative humidity, carbon dioxide enrichment	4
3	Design and construction of greenhouses- site selection, orientation, design, construction, design for ventilation requirement using exhaust fan system	4
4	Selection of equipment; Greenhouse cooling system- methods, ventilation with roof and side ventilators, evaporative cooling, different shading materials, fogging, combined fogging and fan-pad cooling system, design of cooling system	5
5	Maintenance of cooling and ventilation systems, pad care, etc.; Greenhouse heating- components, methods	2
6	Design of heating system; Root media- types, soil and soilless media, composition, estimation, preparation and disinfection, bed preparation	2
7	Planting techniques in green house cultivation; Irrigation in greenhouse and net house- water quality, types of irrigation system, components, design, installation and material requirement; Fogging system for greenhouses and net houses- introduction, benefits, design, installation and material requirement	3
8	Maintenance of irrigation and fogging systems, Fertilization- nutrient deficiency symptoms and functions of essential nutrient elements, principles of selection of proper application of fertilizers, fertilizer scheduling, rate of application of fertilizers, methods, automated fertilizer application	4
9	Greenhouse climate measurement, control and management; Insect and disease management in greenhouse and net houses	2
10	Selection of crops for greenhouse cultivation, major crops in greenhouse- irrigation requirement, fertilizer management, cultivation, harvesting and post-harvest techniques	4
11	Economic analysis	1
Total		32

Practical		
Sr. No.	Topic	No. of Practical
1	Estimation of material requirement for construction of greenhouse	2
2	Determination of fertilization schedule and rate of application for various crops	1
3	Estimation of material requirement for preparation of root media; Root media preparation, bed preparation and disinfections	2
4	Study of different planting techniques; Design and installation of irrigation	2

	system	
5	Design and installation of fogging system; Study of different greenhouse environment control instruments	2
6	Study of operation, maintenance and fault detection in irrigation system	2
7	Study of operation, maintenance and fault detection in fogging system	1
8	Economic analysis of greenhouses and net houses	2
9	Visit to greenhouses	2
	Total	16

Suggested Reading

1. Singh B and Singh B. 2014. *Advances in protected cultivation*. New India Publishing Company.
2. Sharma P. 2007. *Precision Farming*. Daya Publishing House New Delhi.

SEMESTER – 8 (Elective course)

Sr. No.	Course Name	Course No.	Credit	L	P	T
20	Environmental Engineering	PFE8.22	3(2+1)	2	1	3

Objective:

To enable the students to understand-

1. The water requirements for domestic, industrial and commercial demand and sources of water supply, analysis of water quality. Importance to sanitation, domestic waste water treatment, sewer design, disposal of waste water in urban and rural areas
2. The air pollution, types of pollutants, and their abetments

Theory:

Importance of safe water supply system; Water requirements for urban and rural areas; domestic, industrial and commercial demand, per capita demand-variation in demand, population estimation-design period, population forecasting methods; Sources of water supply- surface and sub-surface sources of water, surface sources-lakes, rivers, reservoirs; Intakes and transportation of water-various types of conduits including gravity conduits such as canals, flumes, aqueducts, pressure conduits-design of pressure pipes as gravity mains, Darcy-Wesbach, Manning, Hazen-William formula, flow in pipes system- forces acting on pressure conduits-cast iron pipes, steel, RCC, PVC, asbestos and concrete pipes, laying of pipes and testing of pipes, testing of pipes; Selection of pumps, efficiency of pumps, economic diameter of pumping mains; Drinking water quality: Indian standards of drinking water; Introduction to water treatment: purification of water supply, sedimentation, filtration-coagulation, water softening, water treatment methods. Importance to sanitation, domestic waste water: quantity, characteristics, disposal in urban and rural areas; Sewer: types, design discharge and hydraulic design, Introduction to domestic wastewater treatment. Design of septic tank, sewerage system-domestic and municipal wastes, storm sewage, flow through sewers, design of sewers, manhole, sewage characteristics, BOD, COD, dissolved oxygen, nitrogen; Solid water collection and disposal, Solid waste quantity, characteristics and disposal for urban and rural areas. Introduction to air pollution, types of pollutants, properties and their effects on living beings, BIS standards for pollutants in air and their abetments.

Practical:

Study of population forecasting problems; Determination of turbidity, pH and EC of water; Study of suspended solids, dissolved solids and total solids; Study of temporary and permanent hardness; Determination of fluorides and chlorides in drinking water; Determination of dissolved oxygen, COD and BOD of water; Study of hydraulics of pipe lines and distribution network design; Visit to a water treatment plant; Study of maintenance of distribution system; Collection of air samples and their analysis; Design of septic tank, sewer pipe lines and waste disposal measures; Visit to a sewage treatment plant; Visit to a municipal solid waste management plant; Visit to a community bio gas plant.

Planning of lectures		
Sr. No.	Topics to be covered in Lecture	Proposed No. of Lectures
1	Importance of safe water supply system; Water requirements for urban and rural areas; domestic, industrial and commercial demand, per capita demand-variation in demand.	3
2	Population estimation-design period, population forecasting methods.	2
3	Sources of water supply- surface and sub-surface sources of water, surface sources-lakes, rivers, reservoirs;	2
4	Intakes and transportation of water-various types of conduits including gravity conduits such as canals, flumes, aqueducts, pressure conduits-design of pressure pipes as gravity mains, Darcy-Wesbach, Manning, Hazen- William formula, flow in pipes system- forces acting on pressure conduits-cast iron pipes, steel, RCC, PVC, asbestos and concrete pipes, laying of pipes and	5
5	Testing of pipes, testing of pipes; Selection of pumps, efficiency of pumps, economic diameter of pumping mains;	3
6	Drinking water quality: Indian standards of drinking water; Introduction to water treatment: purification of water supply, sedimentation, filtration-coagulation, water softening, water treatment methods.	3
7	Importance to sanitation, domestic waste water: quantity, characteristics, disposal in urban and rural areas;	3
8	Sewer: types, design discharge and hydraulic design, Introduction to domestic wastewater treatment. Design of septic tank, sewerage system-domestic and municipal wastes, storm sewage, flow through sewers, design of sewers, manhole, sewage characteristics, BOD, COD, dissolved oxygen, nitrogen;	5
9	Solid waste collection and disposal, Solid waste quantity, characteristics and disposal for urban and rural areas.	3
10	Introduction to air pollution, types of pollutants, properties and their effects on living beings, BIS standards for pollutants in air and their abetments.	3
Total		32

Practical		
Sr. No.	Topic	No. of Practical
1	Study of population forecasting problems.	1

2	Determination of turbidity, pH and EC of water.	2
3	Study of suspended solids, dissolved solids and total solids.	1
4	Study of temporary and permanent hardness.	1
5	Determination of fluorides and chlorides in drinking water.	1
6	Determination of dissolved oxygen, COD and BOD of water.	1
7	Study of hydraulics of pipe lines and distribution network design.	2
8	Visit to a water treatment plant.	1
9	Study of maintenance of distribution system.	1
10	Collection of air samples and their analysis.	1
11	Design of septic tank, sewer pipe lines and waste disposal measures.	1
12	Visit to a sewage treatment plant.	1
13	Visit to a municipal solid waste management plant.	1
14	Visit to a community bio gas plant.	1
	Total	16

Suggested Readings:

1. Chatterjee, A. K. 2006. Water Supply, Waste Disposal & Environmental Engineering. Khanna Publishers, Delhi
2. Garg, S. K. 1977. Environmental Engineering. Vol, I and II. Khanna Publishers, Delhi
3. Rao, P. V. 2002. Text book of Environmental Engineering. Prentice Hall of India Pvt. Ltd.

SEMESTER – 8 (Elective course)

Sr. No.	Course Name	Course No.	Credit	L	P	T
21	Development of Processed Food Products	PFE-8.23	3(2+1)	2	1	3

Objective

To enable the students to know about the 1. Unit operations and equipment used for different food processing operations 2. Processing technologies for value addition of cereals, pulses, oilseeds, vegetables, fruits, milk, fish, meat and poultry products

Course content: Theory:

Process of new product development; Process flow chart with mass and energy balance; Unit operations and equipment for processing; Technologies for value addition of cereals, pulses and oil seeds- milled, puffed, flaked, roasted and malted products, bakery products, snack food, extruded products; Technologies for value added products from fruits, vegetables and spices as canned foods, frozen foods, dried foods, fried foods, fruit juices, sauce, sugar based confectionery, candy, fermented products, spice extract; Technologies for value addition of liquid foods such as milk, sugarcane juice, etc.; Technologies for value addition of forest produce as mahua and tamarind; Technology for processing of animal produce, viz. meat, poultry, fish, egg products; Technologies for preparation of health foods, nutraceuticals and functional food; Organic food processing.

Practical:

Process design and preparation of process flow chart; Preparation of different value added products; Visit to roller flour mill, rice mill, spice grinding mill, milk plant, dal and oil mill, fruit/vegetable processing plant, sugar mill and other food processing industries & study of operations and machinery.

Planning of lectures		
Sr. No.	Topics to be covered in Lecture	Proposed No. of Lectures
1.	Process of new product development; Process flow chart with mass and energy balance;	4
2.	Unit operations and equipment for processing; Technologies for value addition of cereals, pulses and oil seeds- milled, puffed, flaked, roasted and malted products, bakery products, snack food, extruded products;	6
3.	Technologies for value added products from fruits, vegetables and spices as canned foods, frozen foods, dried foods, fried foods, fruit juices, sauce, sugar based confectionery, candy, fermented products, spice extract;	6
4.	Technologies for value addition of liquid foods such as milk, sugarcane juice, etc.;	4
5.	Technologies for value addition of forest produce as mahua and tamarind;	4
6.	Technology for processing of animal produce, viz. meat, poultry, fish, egg products;	4
7.	Technologies for preparation of health foods, nutraceuticals and functional food; Organic food processing.	4
Total		32

Sr. No.	Topic	No. of Practicals
1.	Process design and preparation of process flow chart;	1
2.	Preparation of different value added products;	3
3.	Visit to roller flour mill,	1
4.	Visit to rice mill,	1
5.	Visit to spice grinding mill,	1
6.	Visit to milk plant,	1
7.	Visit to dal mill,	1
8.	Visit to oil mill,	1
9.	Visit to fruit processing plant,	1
10.	Visit to vegetable processing plant,	1
11.	Visit to sugar mill and other food processing industries &	3
12.	Study of operations and machinery.	1
Total		16

Suggested Readings

1. Acharya, K. T. 2017. Everyday Indian Processed Foods. National Book Trust.
2. Dash, S. K., Chandra, P. and Kar, A. 2024. Food Engineering Principles and Practice. CRC Press, Boca Raton, USA

3. Mudambi, S. R., Rao, S. M. and Rajgopal, M. V. 2006. Food Science. New Age International Publishers.
4. Negi, H. P. S., Sharma, S. and Sekhon, K. S. 2007. Handbook of Cereal Technology. Kalyani Pub.
5. Potter, N. N. and Hotchkiss, J. H. 1995. Food Science. Chapman and Hall Pub.
6. Rao, D. G. 2009. Fundamentals of Food Engineering. PHI Learning Pvt. Ltd, New Delhi.
7. Srivastava, R. P. and Kumar, S. 2019. Fruit and Vegetable Preservation: Principles and Practices. International Book Distributing Company

SEMESTER – 8 (Elective course)

Sr. No.	Course Name	Course No.	Credit	L	P	T
22	Food Packaging Technology	PFE 8.24	3 (2+1)	2	1	3

Objective:

To enable the students to

1. Understand the interaction of food, packaging and environment
2. Understand the different methods of package development and packaging
3. Select the best type and form of packaging of specific food for specific end users

Theory:

The shelf life of food materials during storage is influenced by various factors, including the interactions of spoilage agents with environmental conditions such as water activity, oxygen levels, light exposure, and pH. Controlling these factors is essential to mitigate spoilage, which can be managed by understanding the general principles of controlling spoilage agents. Additionally, there is a distinction between food infection (caused by the ingestion of pathogens), food intoxication (caused by toxins produced by microorganisms), and food allergies (immune responses to certain food proteins). Packaging plays a critical role in food preservation, offering protection from spoilage agents while extending shelf life. The requirements and importance of food packaging encompass considerations for environmental impact, material selection, and application. Packaging systems can be classified as flexible or rigid, retail or bulk, and categorized into various levels. Packaging materials include metal cans (e.g., two-piece and three-piece cans), plastics (polymers and laminates with specific barrier properties), glass containers (manufactured with specific types of glass and closures), and paper and paperboard (processed for enhanced barrier properties). Each material has unique advantages and disadvantages, influencing its suitability for different commodities. Advancements in packaging include technologies like Controlled Atmosphere Storage (CAS), Modified Atmosphere Packaging (MAP), shrink and cling wraps, vacuum packaging, and gas packaging. Emerging trends such as active and smart packaging aim to improve functionality and food safety. Nutritional labeling is another critical aspect of packaging, providing consumers with essential product information. Packaging requirements vary between raw and processed foods, necessitating careful selection of materials to ensure product safety and quality. Environmental considerations include the disposal and recycling of packaging waste, with growing emphasis on sustainability. Package testing ensures the reliability of packaging materials, involving various tests for flexible materials (e.g., thickness, tensile strength, haze), rigid materials (e.g., visual defects, impact strength), semi-rigid materials, and specific tests for paper (e.g., bursting strength, folding endurance), plastics (e.g., polymer identification), aluminum foils (e.g.,

pinholes), glass containers (e.g., color and dimensions), and metal containers (e.g., pressure tests). These assessments ensure that packaging materials meet the required standards for protecting and preserving food products effectively.

Practical:

Identification of various types of packaging materials and the determination of their tensile and compressive strength to assess mechanical durability. Tests include both destructive and non-destructive methods for evaluating the structural integrity and quality of glass containers. The process also includes vacuum packaging of agricultural produce to study its effectiveness in preservation. Additionally, the tearing strength of paperboard and the thickness of packaging materials are measured to ensure quality standards. Grease-resistance tests are performed on plastic pouches, while the bursting strength of packaging materials is evaluated to determine their capacity to withstand pressure. The water-vapor transmission rate is measured to analyze the moisture barrier properties of packaging materials. Shrink wrapping is applied to various horticultural produce to examine its effectiveness. Further tests include assessing the chemical resistance of packaging materials and performing drop tests on food packages to evaluate their durability during handling. The activities are complemented by visits to relevant industries for practical exposure to packaging technologies and practices.

Planning of lectures		
Sr. No.	Topics to be covered in Lecture	Proposed No. of Lectures
1	Factors affecting shelf life of food material during storage, interactions of spoilage agents with environmental factors as water, oxygen, light, ph, etc.	2
2	General principles of control of the spoilage agents.	1
3	Difference between food infection, food intoxication and allergy.	2
4	Packaging of foods, requirement, importance and scope, environmental considerations.	2
5	Packaging systems, types: flexible and rigid; retail and bulk; levels of packaging; Different types of packaging materials, their key properties and applications.	2
6	Metal cans- manufacture of two pieces and three piece cans.	1
7	Plastic packaging- different types of polymers and lamination used in food packaging and their barrier properties.	1
8	Manufacture of plastic packaging materials, profile extrusion, blown film/ sheet extrusion, blow molding, extrusion blow molding, injection blow molding, stretch blow molding, injection molding.	2
9	Glass containers- types of glass used in food packaging, manufacture of glass and glass containers, closures for glass containers.	2
10	Paper and paper board packaging-paper and paper board manufacture process, modification of barrier properties and characteristics of paper/ boards.	2
11	Relative advantages and disadvantages of different packaging materials and Effect of these materials on packed commodities.	2
12	Nutritional labelling on packages.	1
13	CAS and MAP, shrink and cling packaging, vacuum and gas packaging; Active packaging, Smart packaging.	2
14	Packaging requirement for raw and processed foods and selection of packaging materials.	2

15	Disposal and recycle of packaging waste.	1
16	Package testing- testing methods for flexible materials, rigid materials and semi rigid materials.	1
17	Tests for paper (thickness, bursting strength, breaking length, stiffness, tear resistance, folding endurance, ply bond test, surface oil absorption test, etc.).	2
18	Plastic film and laminates (thickness, tensile strength, gloss, haze, burning test to identify polymer, etc.).	1
19	Aluminium foil (thickness, pin holes, etc.).	1
20	Glass containers (visual defects, colour, dimensions, impact strength, etc.).	1
21	Metal containers (pressure test, product compatibility, etc.)	1
Total		32

Practical's		
Sr. No.	Topic	No. of Practical's
1	Identification of different types of packaging materials.	2
2	Determination of tensile/ compressive strength of given material/ package.	2
3	To perform different destructive and non-destructive tests for glass containers.	2
4	Vacuum packaging of agricultural produces.	1
5	Determination of tearing strength of paper board.	1
6	Measurement of thickness of packaging materials.	1
7	To perform grease-resistance test in plastic pouches.	1
8	Determination of bursting strength of packaging material.	1
9	Determination of watervapour transmission rate.	1
10	Shrink wrapping of various horticultural produce.	1
11	Testing of chemical resistance of packaging materials.	1
12	Determination of drop test of food package	1
13	Visit to relevant industries.	1
Total		16

Suggested Readings:

1. Coles, R., McDowell, D. and Kirwan, M. J. 2003. Food Packaging Technology. Blackwell Publishing Co.
2. Gosby, N. T. 2001. Food Packaging Materials. Applied Science Publication
3. John, P. J. 2008. A Handbook on Food Packaging. Narendra Publishing House.
4. Mahadevia, M. and Gowramma, R. V. 2007. Food Packaging Materials. Tata McGraw Hill.
5. Robertson, G. L. 2001. Food Packaging and Shelf life: A Practical Guide. Narendra Publishing House.
6. Robertson, G. L. 2005. Food Packaging: Principles and Practice. Second Edition. Taylor and Francis

SEMESTER – 8 (Elective course)

Sr. No.	Course Name	Course No.	Credit	L	P	T
23	Food Plant and Equipment Design	PFE8.25	3 (2 + 1)	2	1	3

Objective:

To enable the students to

1. Understand the managerial aspects of food processing plant
2. Understand Govt. policy on small and medium scale food processing enterprise
3. Understand the procedure of obtaining license and registration for operating food processing business

Theory:

Food plant location, selection criteria for plant location; Selection of processes and plant capacity; Requirements of plant building and its components, flow diagrams; Selection of equipment, process and controls; Objectives and principles of food plant layout; Different types of plant layout; Consideration of salient features of processing plants for cereals, pulses, oilseeds, horticultural and vegetable crops, poultry, fish and meat products, milk and milk products for equipment selection and layout. Application of design engineering for processing equipment; Design parameters and general design procedure; Material specification, types of material for process equipment; Design codes, pressure vessel design; Design of cleaners; Design of tubular heat exchanger, shell and tube heat exchanger and plate heat exchanger; Design of belt conveyer, screw conveyer and bucket elevator; Design of grain dryers; Design of milling equipment; Optimization of design with respect to process efficiency, energy and cost; Computer Aided Design.

Practical:

Study of salient features and layout of pre-processing house; Study of salient features, design and layout of different types of food processing industries, viz. milk and milk product plants, modern rice mill, bakery, fruits and vegetables processing unit; Evaluation of given layout; Design of pressure vessel; Design of cleaners; Design of milling equipment; Design of tubular heat exchanger, shell and tube type heat exchanger, plate heat exchanger; Design of grain dryer; Design of belt conveyor, bucket elevator, screw conveyor

Planning of lectures		
Sr. No.	Topics to be covered in Lecture	Proposed No. of Lectures
1	Food plant location, selection criteria for plant location; Selection of processes and plant capacity; Requirements of plant building and its components, flow diagrams.	2
2	Selection of equipment, process and controls; Objectives and principles of food plant layout; Different types of plant layout.	3
3	Consideration of salient features of processing plants for cereals, pulses, oilseeds, horticultural and vegetable crops, poultry, fish and meat products, milk and milk products for equipment selection and layout.	3
4	Application of design engineering for processing equipment; Design parameters and general design procedure; Material specification, types of material for process equipment.	3
5	Design codes.	1
6	Pressure vessel design.	3

7	Design of cleaners.	2
8	Design of tubular heat exchanger.	1
9	Design of shell and tube heat exchanger.	1
10	Design of plate heat exchanger.	1
11	Design of belt conveyer	1
12	Design of screw conveyer	1
13	Design of bucket conveyer	1
14	Design of grain dryers.	2
15	Design of milling equipment.	2
16	Optimization of design with respect to process efficiency, energy and cost.	2
17	Computer Aided Design.	3
Total		32

Practical		
Sr. No.	Topic	No. of Practical
1	Study of salient features and layout of pre-processing house.	2
2	Study of salient features, design and layout of different types of food processing industries, viz. milk and milk product plants, modern rice mill, bakery, fruits and vegetables processing unit.	2
3	Evaluation of given layout. (Milk and milk product plants, modern rice mill, bakery, fruits and vegetables processing unit.)	2
4	Design of pressure vessel.	1
5	Design of cleaners.	1
6	Design of milling equipment.	1
7	Design of tubular heat exchanger.	1
8	Design of shell and tube type heat exchanger.	1
9	Design of Plate heat exchanger.	1
10	Design of grain dryer.	1
11	Design of belt conveyor.	1
12	Design of bucket elevator.	1
13	Design of screw conveyor.	1
Total		16

Suggested Readings:

1. Bhattacharyya, B. C. 2008. Introduction to Chemical Equipment Design. CBS Publishers and Distributors.
2. Dawande, S. D. 1999. Process Design of Equipment. Central Techno Publication, Nagpur.
3. Geankoplis, C. J. 1993. Transport Processes and Unit Operations. Prentice-Hall.
4. Hall, H. S. and Rosen, Y. S. 1963. Milk Plant Layout. FAO Publication, Rome.
5. López Antonio Gómez. 2005. Food Plant Design. T&F India.
6. Mahajan, M. 2016. Operations Research. Dhanpat Rai and Company Private Limited, Delhi.
7. Mahajani, V. V. and Umarji, S. B. 2009. Process Equipment Design. Macmillan.
8. Maroulis, Z. B. and Saravacos, G. D. 2007. Food Plant Economics. Taylor and Francis, LLC.
9. Maroulis, Z. B. 2003. Food Process Design. Marcel Dekker, Inc, Cimarron Road, Monticello, New York 12701, USA.
10. Robberts Theunis, C. 2016. Food Plant Engineering Systems. CRC Press, Washington

SEMESTER – 8 (Elective course)

Sr. No.	Course Name	Course No.	Credit	L	P	T
24	Emerging Technologies in Food Processing	PFE-8.26	3(3+0)	3	0	3

Objective

To enable the students to 1. Know about various emerging technologies in food processing. 2. Know the practical applications of various emerging technologies in food processing

Course content: Theory:

Introduction, different emerging technologies and their scope and applications. Principle, equipment and applications of ohmic heating, infrared heating, dielectric heating, microwave heating systems, radio frequency heating equipment, combined microwave vacuum drying new hybrid drying technologies. Principles and equipment for Vacuum processing, High pressure processing, Pulsed electric field processing, Ultrasonication, Gamma irradiation/ ionising radiation, Ultraviolet radiation processing. Pulsed X-ray processing, Pulsed light processing, Cold plasma Processing, Ozone treatment, Electron beam processing, Static and oscillating magnetic fields, Dense phase carbon dioxide, High voltage arc discharge. Nanomaterial utilisation in food processing, manufacture of nanomaterials, applications.

Planning of lectures		
Sr. No.	Topics to be covered in Lecture	Proposed No. of Lectures
1.	Introduction, different emerging technologies and their scope and applications.	4
2.	Principle, equipment and applications of ohmic heating, infrared heating, dielectric heating, microwave heating systems,	6
3.	Principle, equipment and applications of radio frequency heating equipment, combined microwave vacuum drying new hybrid drying technologies.	8
4.	Principles and equipment for vacuum processing, High pressure processing, Pulsed electric field processing.	6
5.	Principles and equipment for Ultrasonication, Gamma irradiation/ ionising radiation, Ultraviolet radiation processing.	6
6.	Pulsed X-ray processing, Pulsed light processing, Cold plasma Processing,	5
7.	Ozone treatment, Electron beam processing,	4
8.	Static and oscillating magnetic fields, Dense phase carbon dioxide, High voltage arc discharge.	4
9.	Nanomaterial utilisation in food processing, manufacture of nanomaterials, applications.	5
Total		48

Suggested Readings

1. Dash, S. K., Chandra, P. and Kar, A. Food Engineering Principles and Practices. CRC

- Press.
2. Passos and Ribeiro. Innovation in Food Engineering – New Techniques and Products. CRC Press.
 3. Sun Da-Wen. Thermal Food Processing – New technologies and Quality Issues. CRC Press.
 4. SunDa-Wen. Emerging technologies in food processing. Elsevier.
 5. Tewari and Juneja. Advances in Thermal and Non-Thermal Food Preservation. Blackwell.

SEMESTER – 8 (Elective course)

Sr. No.	Course Name	Course No.	Credit	L	P	T
25.	Processing of Livestock, Fish and Marine Products	PFE8.27	3 (2 + 1)	2	1	3

Objective:

To enable the students to

1. Learn various processes and methods for processing of livestock, fish and marine products
2. Understand the livestock and marine product processing and its applications in industries

Theory:

Production, economics, and processing scenario of meat, fish, and poultry; Processing and preservation of eggs, production of egg yolk and egg yellow powder; Poultry processing: Unit operations for various poultry products; Fish processing: Unit operations for various fish products; Preservation of meat by dehydration, freezing, pickling, curing, cooking and smoking; preservation of meat using ionizing radiation; preservation of meat using antibiotics and chemical additives; Eating quality of meat and discoloration; water-holding capacity and juiciness in cooked and uncooked meat; Meat texture and tenderness: measurement, factors affecting texture and tenderness, artificial tenderizing; Abattoir design and layout, meat plant sanitation and safety; By-products utilization.

Practical:

Hands on exercise on the processing of fish, meat and egg and preparation of value-added products; Visit to processing plants.

Planning of lectures		
Sr. No.	Topics to be covered in Lecture	Proposed No. of Lectures
1	Production, economics, and processing scenario of meat, fish, and poultry.	3
2	Processing and preservation of eggs, production of egg yolk and egg yellow powder.	3
3	Poultry processing: Unit operations for various poultry products.	3
4	Fish processing: Unit operations for various fish products.	3
5	Preservation of meat by dehydration, freezing, pickling, curing, cooking and smoking.	3
6	Preservation of meat using ionizing radiation.	2
7	Preservation of meat using antibiotics and chemical additives.	2
8	Eating quality of meat and discoloration; water-holding capacity and	3

	juiciness in cooked and uncooked meat.	
9	Meat texture and tenderness: measurement, factors affecting texture and tenderness, artificial tenderizing.	3
10	Abattoir design and layout.	3
11	Meat plant sanitation and safety	3
12	By-products utilization.	1
Total		32

Practical		
Sr. No.	Topic	No. of Practical
1	Hands on exercise on the processing of fish.	2
2	Hands on exercise on the processing of meat.	2
3	Hands on exercise on the processing of egg.	2
4	Preparation of value-added products from fish.	2
5	Preparation of value-added products from meat.	2
6	Preparation of value-added products from egg.	2
7	Visit to fish and its value-added products processing plants.	1
8	Visit to meat and its value-added products processing plants.	1
9	Visit to egg production (Poultry houses) and its value-added products processing plants.	2
Total		16

Suggested Readings:

1. Bechtel, P.J. Muscle as Food. Academic Press.
2. Hui, Y. H. Handbook of Meat and Meat Processing. CRC Press.
3. Lawrie, R. A. and Ledward, D. Lawrie's Meat Science. Woodhead Publishing.
4. Stadelmen, W. J. and Cotterill, O.J. Egg Science and Technology. CRC press

SEMESTER – 8 (Elective course)

Sr. No.	Course Name	Course No.	Credit	L	P	T
26.	Food Business Management and Entrepreneurship Development	PFE8.28	3 (3 + 0)	3	0	3

Objective:

To enable the students to learn various aspects of business management and entrepreneurship development in food processing

Course content:

Theory:

Introduction and definitions related with project management and entrepreneurship; Fundamentals of project management and entrepreneurship development; Project formulation: market survey techniques, project identification, project selection, project proposal, work breakdown structure; Network scheduling: activity, networks, use of CPM, PERT in project scheduling. Resource planning, resource allocation, project scheduling with limited resources; Estimation of project costs, earned value analysis, project techno-economic viability, break-even analysis. Identification of business opportunity in food processing sector; Government policies for promotion of entrepreneurship in food processing; Launching and organizing an enterprise, enterprise selection, market assessment, feasibility study, SWOT analysis; Resource mobilization.

Financial institution in promoting entrepreneurship; Supply chain management; Case study of a food business.

Planning of lectures		
Sr. No.	Topics to be covered in Lecture	Proposed No. of Lectures
1	Introduction and definitions related with project management and entrepreneurship.	2
2	Fundamentals of project management and entrepreneurship development.	3
3	Project formulation: market survey techniques, project identification, project selection, project proposal, work breakdown structure.	5
4	Network scheduling: activity, networks, use of CPM, PERT in project scheduling.	4
5	Resource planning, resource allocation, project scheduling with limited resources;	3
6	Estimation of project costs, earned value analysis, project techno-economic viability, break-even analysis.	4
7	Identification of business opportunity in food processing sector.	2
8	Government policies for promotion of entrepreneurship in food processing.	3
9	Launching and organizing an enterprise, enterprise selection, market assessment, feasibility study, SWOT analysis.	6
10	Resource mobilization.	2
11	Financial institution in promoting entrepreneurship.	2
12	Supply chain management.	2
13	Case study of a food business.	2
Total		40

Suggested Readings:

1. Awasthi D and Jaggi R. Entrepreneurship and Management Inputs for Entrepreneurs in Food Processing Sector. Ahmedabad ED IInd
2. Bell, G. F. and Balkwill, J. Management and Engineering. Prentice Hall International
3. Bharatia, C. R. Food Technology and Entrepreneurship Management. Surendra Publications

4. Jordan, Lisa. Food Industry: Food Processing and Management. 2 edn. Callisto

SEMESTER – 8 (Elective course)

Sr. No.	Course Name	Course No.	Credit	L	P	T
27.	MATLAB programming	CSE8.29	3(1+2)	1	2	3

Objective

To enable the students to know the different features of MATLAB and have hands-on exercise on it and use the MATLAB for different agricultural engineering applications

Theory

Introduction: platform & features, prerequisites & system requirements, advantages & disadvantages; Commands, environment, working with variables & arrays, workspace, variables & functions, data types, operator, formatting text

MATLAB Control Statements: if statement, if-else statement, if-elseif statement, nested if-else, switch; MATLAB loops: for loop, while loop, nested loop, break, continue; MATLAB error control: error control statement-try & catch Arrays and functions: matrices & arrays, multi-dimensional arrays, compatible array, sparse matrices; Functions: normal functions, predefined functions, user-defined functions, anonymous Function

2D Plots: fplot(), Semilogx(), Semilogy(), loglog(), fill(), Bar(), errorbar(), barh(), plotyy(), area(), Pie(), hist(), stem(), Stairs(), compass(), comet(), contour(), quiver(), pcolor();

3D Plots: plot3(), fill3(), contour3(), surf(), surfc(), mesh(), meshz(), waterfall(), stem3(), ribbon(), sphere(), ellipsoid(), cylinder(), slice()

Practical

Hands on experience with MATLAB functionalities and its installation on different platforms; MATLAB project based on real time Agricultural Engineering problems.

Planning of lectures		
SN	Topics to be covered in lecture	Proposed No. of Lecture
1	Introduction to MATLAB: Platform, Features, Prerequisites, System Requirements, Advantages, and Disadvantages.	1
2	MATLAB Environment, Commands, Working with Variables, Arrays, and Data Types.	1
3	Operators and Text Formatting	1
4	Control Statements	2
5	Loops	2
6	Error Control	1
7	Arrays and Matrices	2
8	Functions	2
9	2D Plots	2
10	3D Plots	2

Practical		
Sr. No.	Topic	No. of Practical's
1	Perform Installation of MATLAB on different platforms (Windows, macOS, Linux).	1
2	Familiarization with MATLAB interface: Command Window, Editor, Workspace, and Help Documentation.	1
3	Practice basic commands and variable creation.	1
4	Perform Array creation and manipulation in MATLAB.	1
5	Practice with operators in MATLAB.	1
6	Perform Text formatting exercises in MATLAB.	1
7	Write and test control statements in MATLAB.	1
8	Solve problems using control statements in MATLAB.	2
9	Implement loops in MATLAB.	1
10	Solve problems using loops in MATLAB.	2
11	Writing error control scripts.	1
12	Perform Debugging and Error Handling Exercises in MATLAB.	1
13	Perform Matrix Operations and Manipulations in MATLAB.	1
14	Exercise working with Multi-Dimensional and Sparse Arrays in MATLAB.	1
15	Exercise Predefined Functions in MATLAB.	1
16	Create and Test User-Defined and Anonymous Functions in MATLAB.	2
17	Creating Basic 2D Plots in MATLAB	1
18	Exercise Advanced 2D Plotting Techniques in MATLAB.	1
19	Create Basic 3D Plots in MATLAB.	1
20	Exercise Advanced 3D Plotting Techniques	1
21	Solve Simple Agricultural Engineering Problems Using MATLAB.	2
22	Data Analysis and Visualization for Agricultural Datasets in MATLAB.	2
23	Project Planning and Problem Identification for MATLAB-Based Agricultural Engineering Applications.	1
24	Writing MATLAB Scripts for Project Implementation.	1
25	Testing and Debugging MATLAB Code for Projects.	2
26	Finalizing Project Results and Visualizations in MATLAB.	1

SEMESTER – 8 (Elective course)

Sr. No.	Course Name	Course No.	Credit	L	P	T
28.	Python Programming	CSE8.30	3(1+2)	1	2	3

Objective

To enable the students to know the different features of Python programming and have hands-on exercise on it and to use the Python programming for different agricultural engineering applications

Theory

Introduction: history, applications, installation;
Variables, data types, keywords, literals, operators, comments

Conditional statements: if else, loops, for loop, while loop, break, continue, pass. strings, lists, tuples, list vs tuple; Functions: functions, built-in functions, lambda functions, Files I/O, modules, exceptions, date, Regex, read CSV File, write CSV File, read excel file, write excel file, assert, list comprehension, collection; Module, math module, OS module, random module, statistics module, sys module, IDEs, arrays, command line arguments, stack & queue, Python OOPs: OOPs concepts, object class, constructors, inheritance, abstraction

Practical

Hands on experience with Python and its installation on different platforms; Accessing python from GUI and from command prompt / terminal, a project based on real time agricultural engineering problems.

Planning of lectures		
SN	Topics to be covered in lecture	Proposed No. of Lecture
1	Introduction to Python Programming: History, Applications, and Installation of Python.	1
2	Python Basics: Variables, Data Types, Keywords, Literals, Operators, and Comments.	1
3	Conditional Statements in Python: if, else, elif, and Nested Conditions.	1
4	Loops in Python: for Loop, while Loop, break, continue, and pass Statements.	1
5	String Manipulation in Python: String Operations, Methods, and Formatting.	1
6	Lists and Tuples in Python: Creation, Indexing, Slicing, Methods, and Differences Between Lists and Tuples.	1
7	Functions in Python: Defining Functions, Built-in Functions, and Lambda Functions.	1
8	File Handling in Python: File I/O Operations, Reading and Writing CSV/Excel Files.	1
9	Modules and Exception Handling in Python: Importing Modules and Handling Exceptions Using try, except, and finally.	1
10	Advanced Data Structures in Python: List Comprehension and Collections (Counter, defaultdict).	1
11	Python Built-in Modules: math, os, random, statistics, and sys Modules.	1
12	Arrays and Command Line Arguments in Python: Working with Arrays and Processing Command Line Arguments.	1
13	Stacks and Queues in Python: Implementation Using Lists and Applications in Agricultural Engineering.	1
14	Introduction to Object-Oriented Programming (OOPs) in Python: Classes, Objects, and Constructors.	1
15	Inheritance and Abstraction in Python: Single and Multiple Inheritance, Abstract Classes.	1
16	Real-Time Applications and Project Discussion: Solving Agricultural Engineering Problems Using Python.	1

Practical

Sr. No.	Topic	No. of Practical's
1	Python Installation and Environment Setup <ul style="list-style-type: none"> • Write a Python program to verify the installation and print "Hello, World!". • Access Python from both GUI and Command Prompt/Terminal. 	1
2	Basic Python Programs <ul style="list-style-type: none"> • Write a Python program to perform arithmetic operations using variables. • Write a Python program to demonstrate the use of different data types. 	1
3	Conditional Statements <ul style="list-style-type: none"> • Write a Python program to check if a number is even or odd using if-else. • Write a Python program to find the largest of three numbers using nested if-else. 	2
4	Loops <ul style="list-style-type: none"> • Write a Python program to print triangle using a for loop. • Write a Python program to find the factorial of a number using a while loop. 	2
5	String Manipulation <ul style="list-style-type: none"> • Write a Python program to reverse a string and check if it is a palindrome. • Write a Python program to count the number of vowels in a string. 	2
6	Lists and Tuples <ul style="list-style-type: none"> • Write a Python program to create a list of numbers and perform operations like append, remove, and sort. • Write a Python program to demonstrate the differences between lists and tuples. 	2
7	Functions <ul style="list-style-type: none"> • Write a Python program to define a function that calculates the area of a circle. • Write a Python program to use a lambda function to find the square of a number. 	2
8	File Handling <ul style="list-style-type: none"> • Write a Python program to read a text file and count the number of lines. • Write a Python program to write data to a CSV file and read it back. 	2
9	Exception Handling <ul style="list-style-type: none"> • Write a Python program to handle division by zero using try-except. • Write a Python program to handle file not found exception. 	2
10	List Comprehension and Collections <ul style="list-style-type: none"> • Write a Python program to create a list of squares using list comprehension. • Write a Python program to count the frequency of elements in a list using the Counter class. 	2
11	Python Built-in Modules	2

	<ul style="list-style-type: none"> Write a Python program to generate random numbers using the random module. Write a Python program to calculate the mean and median of a dataset using the statistics module. 	
12	Arrays and Command Line Arguments <ul style="list-style-type: none"> Write a Python program to implement basic array operations using the array module. Write a Python program to accept command line arguments and perform operations. 	2
13	Stacks and Queues <ul style="list-style-type: none"> Write a Python program to implement a stack using a list. Write a Python program to implement a queue using a list. 	2
14	Object-Oriented Programming (OOPs) <ul style="list-style-type: none"> Write a Python program to create a class Student with attributes and methods. Write a Python program to demonstrate the use of constructors in a class. 	2
15	Inheritance and Abstraction <ul style="list-style-type: none"> Write a Python program to implement single inheritance between two classes. Write a Python program to demonstrate abstraction using an abstract class. 	2
16	Write a Python program to solve a real-time agricultural engineering problem (e.g., crop yield prediction, soil moisture analysis).	4

SEMESTER – 8 (Elective course)

Sr. No.	Course Name	Course No.	Credit	L	P	T
29.	Artificial Intelligence	CSE8.31	3(2+1)	2	1	3

Objective

To enable the students to know the details of problem solving in artificial intelligence, details of knowledge, reasoning, and planning in artificial intelligence, learning, communicating, perceiving, and acting in artificial intelligence

Theory

Foundation and history of artificial intelligence; Intelligent agents, structure of agents; AI programming languages, introduction to LISP and PROLOG; Solving problems by searching, problem solving agents, infrastructure for search algorithms, measuring problem solving performance, blind search strategies, breadth first search, depth first search, heuristic search techniques, best first- A* algorithm, AO* algorithm; Hill climbing search, Genetic algorithms; Games, game tree, game playing, min-max algorithms, alpha beta pruning; Logical agents, knowledge representation issues, predicate logic, logic programming; Constraint satisfaction problems, backtracking search; Knowledge representation- representing knowledge using rules, rules based deduction systems, semantic nets, frames, inheritance, temporal reasoning;

Quantifying uncertainty, reasoning under uncertainty; Probabilistic reasoning- review of probability, Baye's probabilistic interferences, Dempstershafer theory, fuzzy reasoning; Classical planning- planning, representation for planning, partial order planning algorithm; Planning and acting in the real world- planning in situational calculus, high-level actions; Supervised learning, artificial neural networks, neural network structures, single-layer feed-forward neural networks (perceptron), multilayer feed-forward neural networks, learning in multilayer networks; Knowledge in learning- a logical formulation of learning, explanation-based learning; Natural language processing- principles of natural language processing; Expert systems, knowledge acquisition concepts; Robotics, AI application to robotics; Current trends in intelligent systems

Practical

Hands on exercise on problem solving in artificial intelligence, details of knowledge, reasoning, and planning in artificial intelligence, learning in artificial intelligence, communicating, perceiving, and acting in artificial intelligence and verifying engineering concepts in artificial intelligence.

Planning of lectures		
SN	Topics to be covered in lecture	Proposed No. of Lecture
1	Module 1: Foundations of Artificial Intelligence <ul style="list-style-type: none"> • Introduction to Artificial Intelligence: History and Foundations • Intelligent Agents: Structure and Types of Agents • AI Programming Languages: Introduction to LISP and PROLOG 	3
2	Module 2: Problem Solving and Search Algorithms <ul style="list-style-type: none"> • Problem-Solving Agents and Search Algorithms • Blind Search Strategies: Breadth-First Search and Depth-First Search • Heuristic Search Techniques: Best-First Search and A* Algorithm • Advanced Search Algorithms: AO* Algorithm and Hill Climbing • Genetic Algorithms: Principles and Applications 	6
3	Module 3: Game Playing and Logical Agents <ul style="list-style-type: none"> • Game Playing: Game Trees and Min-Max Algorithm • Alpha-Beta Pruning for Optimized Game Playing • Logical Agents: Knowledge Representation and Predicate Logic • Logic Programming and Constraint Satisfaction Problems 	5
4	Module 4: Knowledge Representation and Reasoning <ul style="list-style-type: none"> • Knowledge Representation Using Rules and Deduction Systems • Semantic Nets, Frames, and Inheritance in Knowledge Representation • Temporal Reasoning and Uncertainty in Knowledge Representation • Probabilistic Reasoning: Bayesian Networks and Inference • Dempster-Shafer Theory and Fuzzy Reasoning 	6
5	Module 5: Planning and Acting <ul style="list-style-type: none"> • Classical Planning: Representation and Algorithms • Partial Order Planning and Situational Calculus • Planning and Acting in Real-World Scenarios 	3
6	Module 6: Learning in Artificial Intelligence	5

	<ul style="list-style-type: none"> Supervised Learning: Concepts and Applications Artificial Neural Networks: Single-Layer and Multilayer Perceptrons Learning in Multilayer Networks: Backpropagation and Optimization Knowledge in Learning: Explanation-Based Learning 	
7	Module 7: Natural Language Processing and Expert Systems <ul style="list-style-type: none"> Principles of Natural Language Processing (NLP) Expert Systems: Knowledge Acquisition and Representation 	3
8	Module 8: Robotics and Current Trends in AI <ul style="list-style-type: none"> AI Applications in Robotics Current Trends in Intelligent Systems 	1

Practical		
Sr. No.	Topic	No. of Practical's
1	Implement of Breadth-First Search and Depth-First Search	1
2	Implement A* Algorithm and Heuristic Search Techniques	1
3	Solve Problems Using Genetic Algorithms	1
4	Implement of Min-Max Algorithm	1
5	Implement Alpha-Beta Pruning Algorithm	1
6	Solve Constraint Satisfaction Problem Using Backtracking	1
7	Build Rule-Based Deduction Systems	1
8	Implement Bayesian Networks for Probabilistic Reasoning	1
9	Implement Fuzzy Reasoning and Uncertainty Handling	1
10	Implement Classical Planning Algorithms	1
11	Implement Partial Order Planning in Real-World Scenarios	1
12	Implement Building and Training Single-Layer Perceptrons	1
13	Implement Multilayer Feed-Forward Neural Networks	1
14	Implement Explanation-Based Learning in AI Systems	1
15	Build a Simple Natural Language Processing System	1
16	Design an Expert System for Knowledge Representation	1

Suggested Reading

- Russell S and Norvig P. 1998. *Artificial Intelligence: A Modern Approach*. Prentice Hall.
- Rich E and Knight K. 1991. *Artificial Intelligence*. Times McGraw-Hill.
- Winston P H. 1992. *Artificial intelligence*. Addition Wesley 3rd Ed.
- Nilson N J. 2002. *Principles of Artificial Intelligence*. Narosa Publishing House.

SEMESTER – 8 (Elective course)

Sr. No.	Course Name	Course No.	Credit	L	P	T
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30.	Advances in Automation and Robotics in Agriculture	CSE8.32	3(2+1)	2	1	3
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Objective

To enable the students to gain advanced knowledge and skill for application of automation and robotics in agriculture, know about the modeling of robot mechanisms, robot control architectures and robot design and considerations for agricultural operations

Theory

Sensors and sensor-driven robot Control, Robot Sensors, Proximity sensors- Infrared sensors, Ultrasonic sensor, Laser range finder, Robot Vision sensors- RGB camera, Thermal Camera, Multispectral sensor, Hyperspectral sensor, Stereo vision system, Optical flow sensor, GPS sensor- RTK, PPK. Sensor noise and uncertainty- Sensor uncertainty, Non-observability, Action uncertainty

Introduction to Robotics and its importance in Agriculture, classification of robots (Anatomy), Automation and Robotics in Intelligent Environments, History of Robotics, Robot manipulators, Mobile robots, Walking Robot, Humanoid Robots, Autonomous Robots, Traditional Industrial Robots, Requirements for Robots in Intelligent Environments, Status and scope in Agriculture; Modeling of robot mechanisms, Kinematics, Dynamics, Robot sensor selection, Active and passive proximity sensors, Low-level control of actuators, Closed-loop control, Control architectures, Traditional planning architectures, Behavior-based control architectures, and Hybrid architectures. Modeling the Robot Mechanism, Forward kinematics, Inverse kinematics, Jacobian calculation, and Mobile Robot Odometry

Robot Actuator Control system, Mass, inertia, friction and force, frequent actuators, control approach Proportional, PI, and PID control, Actuators- DC motor, BLDC motor, Linear actuator, Servomotor, Stepper motor, Drivers and control algorithms. Ground Control station system, Transmitters, and receivers, PWM, PPM signal, telemetry system, band, and frequency. Transmitter, receiver, PWM, PPM, Telemetry system, band and frequency; Robot Navigation, Path planning addresses and computing a trajectory, Algorithms, and control navigation, mission planning and control, Geofencing, Triggering, Software for robot control and navigation, Probabilistic Robot Localization- Localization, Mapping, and Model Building; Robot Control Architectures, Deliberative Control Architecture- Perception, modeling, planning, task execution and motor control, Advantages, and disadvantages; Behavior-Based Robot Control Architectures, Reactive, Behavior-Based Control Architectures, Hybrid Control Architectures, Intuitive Robot Interfaces-Graphical programming interfaces, Deictic (pointing) interfaces, Voice recognition and reaction

AI adaptation and Learning for Robots-Supervised learning, Learning Sensory Patterns - Neural networks, Decision trees, Reinforcement Learning, AI programming techniques. Classical AI, the concept of expert system, conflict resolution, multiple rules, forward chaining, and backward chaining. Advantages and disadvantages of expert system;

Robot design and considerations for agricultural operations, Robots for Seedbed preparation, sowing and transplanting, weeding operation-mechanical and chemical, fruit harvesting, robots for greenhouse application, moisture management, post-harvest losses management, dairy and food packaging, humanoid robots, cattle and poultry farm management, VRT robots, Driverless Autonomous tractor.

Practical

Demonstration of different types of robots and their use in agricultural operations; Robot mechanisms, forward kinematics, inverse kinematics calculations and modeling; PID control of actuators and their calibration for precise control; Practical on robot actuator control

systems for determination of mass, inertia, friction, and forces; Calibration of PID controllers for close-loop controls of the system; Mission planning and computation of trajectory for a robot through Python coding and other software; Sensor-driven robot control for obstacle avoidance using different sensors; Calibration of GPS sensors and 3-D fixing for precise control; Robot control architecture design, control, and behavior study; Robot-supervised learning for sensory patterns to detect leaves, flowers, fruit, animal, human body, etc; Robot design consideration for sowing and transplanting operation; Robot design for weeding operation; Robotic arm design for fruit detection and harvesting; Robotic prime mover design for greenhouse operations for selected crops; Automation of machines for food packaging; Robots for food control and cleaning in cattle and poultry farms; Robots for variable rate application of agricultural inputs; Driverless and autonomous tractor for straight control calibration of movement; Control of humanoid robots for selected agricultural operations and active voice command control.

Planning of lectures		
SN	Topics to be covered in lecture	Proposed No. of Lecture
1	Module 1: Introduction to Robotics and Automation in Agriculture <ul style="list-style-type: none"> • Introduction to Robotics and its Importance in Agriculture • History of Robotics and its Evolution in Agriculture • Classification of Robots: Anatomy and Types (Manipulators, Mobile Robots, Humanoid Robots, etc.) • Automation and Robotics in Intelligent Environments • Requirements for Robots in Agriculture: Status and Scope 	5
2	Module 2: Sensors and Sensor-Driven Robot Control <ul style="list-style-type: none"> • Introduction to Robot Sensors and Their Role in Agriculture • Proximity Sensors: Infrared, Ultrasonic, and Laser Range Finders • Robot Vision Sensors: RGB, Thermal, Multispectral, and Hyperspectral Cameras • Stereo Vision Systems and Optical Flow Sensors • GPS Sensors: RTK and PPK for Precision Agriculture • Sensor Noise and Uncertainty: Challenges and Solutions 	5
3	Module 3: Modeling of Robot Mechanisms <ul style="list-style-type: none"> • Kinematics: Forward and Inverse Kinematics • Dynamics of Robot Mechanisms • Jacobian Calculation and Mobile Robot Odometry • Robot Sensor Selection and Integration 	4
4	Module 4: Robot Actuators and Control Systems <ul style="list-style-type: none"> • Actuators in Robotics: DC Motors, BLDC Motors, Servomotors, and Stepper Motors • Control Approaches: Proportional (P), PI, and PID Control • Low-Level Control of Actuators and Closed-Loop Control • Ground Control Station Systems: Transmitters, Receivers, and Telemetry 	4
5	Module 5: Robot Navigation and Control Architectures <ul style="list-style-type: none"> • Robot Navigation: Path Planning and Trajectory Computation • Mission Planning, Geofencing, and Triggering 	5

	<ul style="list-style-type: none"> • Probabilistic Robot Localization: Mapping and Model Building • Deliberative Control Architectures: Perception, Planning, and Execution • Behavior-Based and Hybrid Control Architectures 	
6	Module 6: AI and Learning in Robotics <ul style="list-style-type: none"> • AI Adaptation for Robots: Supervised and Reinforcement Learning • Learning Sensory Patterns: Neural Networks and Decision Trees • Classical AI: Expert Systems and Conflict Resolution 	5
7	Module 7: Robot Design for Agricultural Operations <ul style="list-style-type: none"> • Robots for Seedbed Preparation, Sowing, and Transplanting • Robots for Weeding: Mechanical and Chemical Methods • Robots for Fruit Harvesting and Greenhouse Applications • Robots for Post-Harvest Management and Food Packaging • Driverless Autonomous Tractors and Variable Rate Technology (VRT) Robots 	5

Practical		
Sr. No.	Topic	No. of Practical's
1	Demonstration of Different Types of Robots and Their Applications in Agriculture	1
2	Forward and Inverse Kinematics Calculations and Modeling	1
3	PID Control of Actuators and Calibration for Precise Control	1
4	Determination of Mass, Inertia, Friction, and Forces in Robot Actuators	1
5	Sensor-Driven Robot Control for Obstacle Avoidance	1
6	Calibration of GPS Sensors for 3-D Fixing and Precision Control	1
7	Mission Planning and Trajectory Computation Using Python	1
8	Design and Study of Robot Control Architectures	1
9	Behavior-Based Control for Agricultural Tasks	1
10	Supervised Learning for Sensory Pattern Detection (Leaves, Flowers, Fruits, etc.)	1
11	Implementation of Neural Networks for Agricultural Object Detection	1
12	Design Considerations for Sowing and Transplanting Robots	1
13	Robotic Arm Design for Fruit Detection and Harvesting	1
14	Robotic Prime Mover Design for Greenhouse Operations	1
15	Automation of Machines for Food Packaging and Cleaning in Farms	1
16	Calibration and Control of Driverless Autonomous Tractors	1

Suggested Reading

1. Ben-Ari, Mordechai, and Francesco Mondada. Elements of robotics. Springer Nature, 2017.
2. John J. Craig, Introduction to Robotics Mechanics and Control, 5 Pearson Education, Inc. Pearson Prentice Hall Pearson Education, Inc. Upper Saddle River,

- NJ, 2005.
3. Mark R. Miller and Rex Miller, Robots and Robotics, Principles, Systems, and Industrial Applications. McGraw-Hill Education, 2017.
 4. Robert. J. Schilling, “Fundamentals of robotics – Analysis and control”, Prentice Hall of India, 1990.
 5. Siegwart, Roland, Illah Reza Nourbakhsh, and Davide Scaramuzza. Introduction to autonomous mobile robots. MIT press, 2011.
 6. T. Bräunl, Embedded Robotics Mobile Robot Design and Applications with Embedded Systems, Springer Berlin Heidelberg, 2013.
 7. Zhang, Dan, and Bin Wei, eds. Robotics and mechatronics for agriculture. CRC Press, 2017.

SEMESTER – 8 (Elective course)

Sr. No.	Course Name	Course No.	Credit	L	P	T
31.	Machine Learning	CSE8.33	3(2+1)	2	1	3

Objective

To enable the students to

1. Know the basics of machine learning
2. Know the applications of machine learning in different fields

Theory

Introduction to Machine Learning, Preliminaries, what is machine learning; varieties of machine learning, learning input/output functions, bias, sample application. Boolean functions and their classes, CNF, DNF, decision lists. Version spaces for learning, version graphs, learning search of a version space, candidate elimination methods ; Neural Networks, threshold logic units, linear machines, networks of threshold learning units, Training of feed forward networks by back propagations, neural networks vs. knowledge-based systems; Statistical Learning, background and general method, learning belief networks, nearest neighbor. Decision-trees, supervised learning of uni-variance decision trees, network equivalent of decision trees, over fitting and evaluation;

Inductive Logic Programming, notation and definitions, introducing recursive programs, inductive logic programming vs decision tree induction; Computational learning theory, fundamental theorem, Vapnik Chervonenkis dimension, linear dichotomies and capacity. Unsupervised learning, clustering methods based on Euclidian distance and probabilities, hierarchical clustering methods. Introduction to reinforcement and explanation-based learning.

Practical

Hands on experience with Machine Learning functionalities and its use in agricultural engineering and allied fields.

Planning of lectures		
SN	Topics to be covered in lecture	Proposed

		No. of Lecture
1	Module 1: Introduction to Machine Learning <ul style="list-style-type: none"> • Introduction to Machine Learning <ul style="list-style-type: none"> ○ Definition, history, and importance of machine learning. ○ Applications of machine learning in different fields (focus on agricultural engineering). • Types of Machine Learning <ul style="list-style-type: none"> ○ Supervised, unsupervised, and reinforcement learning. ○ Input/output functions and bias in machine learning. • Sample Applications of Machine Learning <ul style="list-style-type: none"> ○ Case studies of machine learning in real-world scenarios. • Boolean Functions and Their Classes <ul style="list-style-type: none"> ○ CNF (Conjunctive Normal Form), DNF (Disjunctive Normal Form), and decision lists. • Version Spaces for Learning <ul style="list-style-type: none"> ○ Version graphs, learning search of a version space, and candidate elimination methods. 	5
2	Module 2: Neural Networks <ul style="list-style-type: none"> • Introduction to Neural Networks <ul style="list-style-type: none"> ○ Threshold logic units and linear machines. • Networks of Threshold Learning Units <ul style="list-style-type: none"> ○ Architecture and working of neural networks. • Training Feedforward Networks <ul style="list-style-type: none"> ○ Backpropagation algorithm and its implementation. • Neural Networks vs. Knowledge-Based Systems <ul style="list-style-type: none"> ○ Comparison and use cases of both approaches. 	5
3	Module 3: Statistical Learning <ul style="list-style-type: none"> • Introduction to Statistical Learning <ul style="list-style-type: none"> ○ Background and general methods. • Learning Belief Networks <ul style="list-style-type: none"> ○ Bayesian networks and probabilistic graphical models. • Nearest Neighbor Algorithm <ul style="list-style-type: none"> ○ k-Nearest Neighbors (k-NN) and its applications. • Decision Trees <ul style="list-style-type: none"> ○ Supervised learning of univariate decision trees. • Overfitting and Evaluation <ul style="list-style-type: none"> ○ Causes of overfitting and methods to evaluate model performance. 	5
4	Module 4: Inductive Logic Programming <ul style="list-style-type: none"> • Introduction to Inductive Logic Programming (ILP) <ul style="list-style-type: none"> ○ Notation, definitions, and basic concepts. • Recursive Programs in ILP <ul style="list-style-type: none"> ○ Introducing recursive programs and their applications. • ILP vs Decision Tree Induction <ul style="list-style-type: none"> ○ Comparison of ILP and decision tree methods. 	3
5	Module 5: Computational Learning Theory <ul style="list-style-type: none"> • Fundamental Theorem of Machine Learning • Vapnik-Chervonenkis (VC) Dimension 	3

	<ul style="list-style-type: none"> • Linear Dichotomies and Capacity models 	
6	Module 6: Unsupervised Learning <ul style="list-style-type: none"> • Introduction to Unsupervised Learning <ul style="list-style-type: none"> ○ Clustering methods based on Euclidean distance. • Probabilistic Clustering Methods <ul style="list-style-type: none"> ○ Gaussian Mixture Models (GMM) and Expectation-Maximization (EM). • Hierarchical Clustering Methods <ul style="list-style-type: none"> ○ Agglomerative and divisive clustering techniques. 	5
7	Module 7: Reinforcement and Explanation-Based Learning <ul style="list-style-type: none"> • Introduction to Reinforcement Learning • Markov Decision Processes (MDP) • Explanation-Based Learning 	3
8	Module 8: Applications and Advanced Topics Case studies and applications in agriculture. Use of machine learning in predicting agricultural outputs. Applications in soil moisture and nutrient analysis. Using ML for pest detection and control in agriculture. Bias, fairness, and ethical issues in ML. Emerging trends and technologies in ML.	3

Practical		
Sr. No.	Topic	No. of Practical's
1	Write a Python program to perform basic data manipulation using NumPy and Pandas.	1
2	Write a Python program to clean and preprocess a dataset.	1
3	Implement linear regression using Scikit-Learn.	1
4	Implement logistic regression for binary classification.	1
5	Write a Python program to build and visualize a decision tree.	1
6	Implement a random forest classifier using Scikit-Learn.	1
7	Write a Python program to implement the k-NN algorithm.	1
8	Build a simple feedforward neural network using TensorFlow/Keras.	1
9	Implement the k-Means clustering algorithm.	1
10	Write a Python program to perform hierarchical clustering.	1
11	Implement PCA for dimensionality reduction.	1
12	Write a Python program to implement a basic Q-learning algorithm.	1
13	Write a Python program to evaluate model performance using metrics like accuracy, precision, and recall.	1
14	Analyze a dataset related to crop yield using machine learning techniques.	1
15	Develop a machine learning project to solve a real-world agricultural engineering problem.	2

Suggested Reading

1. Andreas, C. Muller. 2009. Introduction to Machine Learning with Python- A guide for data scientists, Sarah Guido, O'Reilly
2. Alpaydin Ethem. 2009. Introduction to Machine learning, Third Edition, MIT Press.
3. Muller J P. and Massaron L. 2021. Machine learning for dummies, 2nd Edition, Wiley.

SEMESTER – 8 (Elective course)

Sr. No.	Course Name	Course No.	Credit	L	P	T
32.	Operations Research	AS8.34	3(3+0)	3	0	3

Objective

To enable the students to

1. Understand the importance of operations research for solving field problems
2. Understand and apply linear programming, transportation problem, etc. for agricultural engineering applications
3. Understand the project planning and network analysis

Theory

Introduction to operations research: elementary concepts and objectives, applications of operations research in decision making; Linear programming problem- mathematical formulation of the linear programming problem and its graphical solution, simplex method, simplex method for maximizing and minimizing, mixed constraints, duality theory, the Primal-vs- Dual solutions; Transportation problem, definition and mathematical formulation, initial basic feasible solution, optimal solution; Assignment problem, introduction and mathematical formulation, solution of Assignment problem; Inventory control, introduction and general notations, economic lot size models with known demand; Replacement theory, introduction and elementary concepts, replacement of items deteriorating with time; Sequencing problem: introduction and general notations, solution of a sequencing problem; Queuing theory: introduction and classification of queues, solution of queuing models; Project planning and network analysis: introduction and basic definitions in Network Analysis, rules for drawing Network Analysis, Critical Path Method (CPM), Project Evaluation and Review Technique (PERT)

Planning of lectures		
Sr. No.	Topics to be covered in Lecture	Proposed No. of Lectures
1.	Introduction to operations research	1
2.	elementary concepts and objectives, applications of operations research in decision making	2
3.	Linear programming problem- mathematical formulation of the linear programming problem and its graphical solution, simplex method, simplex method for maximizing and minimizing, mixed constraints, duality theory, the Primal-vs- Dual solutions	7
4.	Transportation problem, definition and mathematical formulation, initial basic feasible solution, optimal solution; Assignment problem	4
5.	introduction and mathematical formulation, solution of Assignment problem	4
6.	Inventory control, introduction and general notations, economic lot size models with known demand	4
7.	Replacement theory, introduction and elementary concepts, replacement of items deteriorating with time	4

8.	Sequencing problem: introduction and general notations, solution of a sequencing problem	3
9.	Queuing theory: introduction and classification of queues, solution of queuing models	5
10.	Project planning and network analysis: introduction and basic definitions in Network Analysis, rules for drawing Network Analysis	4
11.	Critical Path Method (CPM)	3
12.	Project Evaluation and Review Technique(PERT)	3
Total		44

Suggested Reading

1. Winston W L. 2004. Operations Research: Applications and Algorithms. Indian University
2. Taha H. 2003. Operations Research. Macmillan Publishing Company

SEMESTER – 8 (Elective course)

Sr. No.	Course Name	Course No.	Credit	L	P	T
33.	Mechatronics	FMPE8.35	3(2+1)	2	1	3

Objective

To enable the students to

1. Know the measurement system, control systems, microprocessor based controllers of A.C. & D.C. motor.
2. Understand the principles behind the working of different data acquisition, digital signal processing
3. Know the different application of microcontrollers, PLC. robotics, robot components, robot classification and specification

Theory

Definition of mechatronics, measurement system, control systems, microprocessor based controllers, mechatronics approach; Sensors and transducers- performance terminology, displacement, position & proximity sensors, photo-electric transducers, flow transducers, optical sensors and transducers;

Actuators and mechanical actuation systems- hydraulic and pneumatic actuation systems, measurement system, electrical actuation systems, A.C. motor, D.C. motor, stepper motor, signal conditioning process, filtering digital signal, data acquisition system, multiplexers, digital signal processing, pulse modulation, data presentation systems

System modelling & control- mathematical models, engineering systems, electro-mechanical & hydraulic-mechanical systems, modelling dynamic systems, transfer functions, control modes & PID controller

Micro-processor & computer- computer and interfacing, micro-computer structure, micro-controllers, application of microcontrollers, PLC, robotics, robot classification and specification, robot components, work envelopes, other basic parameters of robots, robot applications, robot applications in manufacturing, material transfer and machine loading/unloading, processing operations like welding & painting, assembly operations, inspection, automation, future applications

Practical

Study of different types transducers; Selection of sensor for a particular application from catalogue and internet; Design of a mechatronics product/ system; Application of mechatronics for enhancing product values; Study of electrical actuation systems with A.C. Motor and with D.C. Motor; Study of electrical actuation systems with Stepper Motor; Study of the PID Controller; Study of the hardware and software of mechatronics kit; Study of the pulse modulation, data presentation systems; Moving a table in X-direction within the range of proximity sensors using Control-X software; Running a motor with PLC; Running a conveyor with computer; Study of the movement of actuating cylinders and sensors.

Planning of lectures		
Sr. No.	Topics to be covered in Lecture	Proposed No. of Lectures
1.	Definition of mechatronics, measurement system, control systems, microprocessor based controllers, mechatronics approach	2
2.	Sensors and transducers-performance terminology, displacement, position & proximity sensors, photo-electric transducers, flow transducers, optical sensors and transducers	4
3.	Actuators and mechanical actuation systems- hydraulic and pneumatic actuation systems, measurement system, electrical actuation systems	3
4.	A.C. motor, D.C. motor, stepper motor, signal conditioning process, filtering digital signal, data acquisition system, multiplexers, digital signal processing, pulse modulation, data presentation systems	4
5.	System modeling & control- mathematical models, engineering systems	2
6.	electro-mechanical & hydraulic-mechanical systems, modeling dynamic systems, transfer functions, control modes & PID controller	4
7.	Micro-processor & computer-computer and interfacing, micro-computer	2

	structure	
8.	micro-controllers, application of microcontrollers, PLC	2
9.	robotics, robot classification and specification, robot components	3
10.	envelopes, other basic parameters of robots, robot applications	2
11.	robot applications in manufacturing, material transfer and machine loading/ unloading	2
12.	processing operations like welding & painting, assembly operations, inspection, automation, future applications	2
Total		32

Sr. No.	Topic	No. of Practicals
1.	Study of different types transducers	1
2.	Selection of sensor for a particular application from catalogue and internet	1
3.	Design of a mechatronics product/ system; Application of mechatronics for enhancing product values	2
4.	Study of electrical actuation systems with A.C. Motor and with D.C. Motor	2
5.	Study of electrical actuation systems with Stepper Motor	1
6.	Study of the PID Controller	1
7.	Study of the hardware and software of mechatronics kit	1
8.	Study of the pulse modulation, data presentation systems	2
9.	Study of Moving a table in X-direction within the range of proximity sensors using Control-X software	2
10.	Study of Running a motor with PLC	1
11.	Study of Running a conveyor with computer	2
12.	Study of the movement of actuating cylinders and sensors.	2
Total		16

Suggested Reading

1. Bolton W. 2015. *Mechatronics*. Pearson Education Asia
2. Stadler W. 1995. *Analytical Robotics and Mechatronics*. McGraw-Hill Inc.
3. Doebelin E O. 1966. *Measurement Systems*. McGraw-Hill Inc.
4. Malvino A P. 1983. *Digital Computer Electronics*. McGraw-Hill Inc.
5. Niku S Y. 2001. *Introduction to Robotics: Analysis, systems and Applications*. Pearson Education International
6. Craig J J. 1986. *Introduction to Robotics*. Pearson Education International

SEMESTER – 8 (Elective course)

Sr. No.	Course Name	Course No.	Credit	L	P	T
34.	Natural Fibers: Extraction & Properties	PFE-8.36	3(2+1)	2	1	3

Objective

To enable the students to 1. Importance of natural fibres and the quality management of natural textile fibres 2. Understand the properties of different types of natural fibres and their extraction

methods 3. Understand the different equipment involved in natural fibres extraction.

Theory:

Introduction to Natural Fibres: Natural fibres definition, Detailed Classification; Natural fibres–physical and chemical properties, Advantages and disadvantages of Natural Fibres; Plant Fibres; Animal Fibres; Applications of Natural Fibres. Identification, characterization and quality management of natural textile fibres. Cotton: Types, Morphology, Physical and Chemical properties, grading and marketing, Organic and Bt cotton, processing and utilization; Wool: types, Morphology, Physical and Chemical Properties, grading and marketing processing and application; Jute: Cultivation- Extraction and Retting methods, physical and mechanical properties, grading and marketing, significance of Jute in Packaging. diversified application of jute; Other (Natural) Textile Fibres: Long Vegetables fibres, Cultivation and extraction of Flax, Sisal, Pineapple leaf, Maize, banana, hemp; Physical and Chemical Properties, grading and marketing, processing and end use application. Silk: Types of Silk, Cultivation of mulberry, production of silk cocoon, storage, Sorting, cooking, brushing, reeling (Methods and Machines), morphology, Physical and Chemical Properties, grading and marketing, processing-degumming and weighting. Physical Properties of Natural fibres: Fibre Morphology; Fibre length, diameter, l/b ratio and its significance; concept of denier and tex; colour and lustre, Fibre defects and root content; cross sectional study of fibres; yarn count, moisture regain, thermal behavior; Mechanical Properties: Stress-stain curve, tenacity, elongation, tensile modulus, bundle strength, compressional and resilience properties.

Practical:

Identification of natural fibres; Extractions of jute, cotton, flax, banana, sisal and ramie; Retting of Jute and Flax; Quality evaluation of jute and other fibres; Determination of mechanical and insulation properties.

Planning of lectures		
Sr. No.	Topics to be covered in Lecture	Proposed No. of Lectures
1.	Introduction to Natural Fibres: Natural fibres definition, Detailed Classification;	2
2.	Natural fibres–physical and chemical properties, Advantages and disadvantages of Natural Fibres; Plant Fibres; Animal Fibres;	3
3.	Applications of Natural Fibres. Identification, characterization and quality management of natural textile fibres.	2
4.	Cotton: Types, Morphology, Physical and Chemical properties, grading and marketing, Organic and Bt cotton, processing and utilization;	3
5.	Wool: types, Morphology, Physical and Chemical Properties, grading and marketing processing and application;	2
6.	Jute: Cultivation- Extraction and Retting methods, physical and mechanical properties, grading and marketing, significance of Jute in Packaging. Diversified application of jute;	3
7.	Other (Natural) Textile Fibres: Long Vegetables fibres, Cultivation and extraction of Flax, Sisal, Pineapple leaf, Maize, banana, hemp;	3
8.	Physical and Chemical Properties, grading and marketing, processing and	2

	end use application.	
9.	Silk: Types of Silk, Cultivation of mulberry, production of silk cocoon, storage, Sorting, cooking, brushing, reeling (Methods and Machines), morphology, Physical and Chemical Properties, grading and marketing, processing-degumming and weighting.	4
10.	Physical Properties of Natural fibres: Fibre Morphology; Fibre length, diameter, l/b ratio and its significance; concept of denier and tex; colour and lustre,	3
11.	Fibre defects and root content; cross sectional study of fibres; yarn count, moisture regain, thermal behavior;	2
12.	Mechanical Properties: Stress-stain curve, tenacity, elongation, tensile modulus, bundle strength, compressional and resilience properties.	3
Total		32

Sr. No.	Topic	No. of Practicals
1.	Identification of natural fibres;	3
2.	Extractions of jute, cotton, flax, banana, sisal and ramie;	6
3.	Retting of Jute and Flax;	2
4.	Quality evaluation of jute and other fibres;	3
5.	Determination of mechanical and insulation properties.	2
Total		16

Suggested Readings

1. Cook, J. G. 2005. Hand Book of Textile Fibers. Wood Head Publishers, London, Vol 1 & 2
2. Corbmann, P. B. 2001. Textile Fiber to Fabric. Mc Graw-Hill International Education, 6th edn.
3. Gohl and Vilensky. 2003. Textile Science. 2nd edn. Mahajan Book Publishers,
4. Mishra, S.P. 1998. Fibre Science and Technology. New Age India International Ltd. New Delhi.
5. Shenai, V. A. 2004. Technology of Textile Processing- Textile Fibers. Sevak Publications.
6. Sreenivasa Murthy, H.V. 1994. Introduction Textile Fibres. Textile Association of India, Bombay.
7. Tammanna and Sonwalkar, N. 2002. Handbook of Silk Technology. Wiley Eastern Limited, New Delhi.

SEMESTER – 8 (Elective course)

Sr. No.	Course Name	Course No.	Credit	L	P	T
35.	Natural Fiber Applications in Agriculture	PFE-8.37	3(2+1)	2	1	3

Objective

To enable the students to 1. Know the different applications of natural fibres such as in soil and

water conservation, packaging, energy production and soil less farming, etc. 2. Understand the economics of using natural fibres for these applications.

Theory:

Natural Fibre based Agrotextiles, Characterization and their application: Overview of Agrotextile, Technical Textile, Non-woven technology, Design principles for Natural Fibre based Agrotextiles, Tensile and Hydro-physical properties, Estimation techniques, Application as crop mulch, Effect on soil properties, Measurement of soil hydrothermal regime, Effects on crop yield, Effects on soil moisture retention and weed population, Application as shade net, Biodegradability, Life cycle and environmental impact, Economic evaluation.

Natural Fibre based Geotextiles, Characterization and their application: Overview of Geotextile in soil and water conservation, Woven technology, Design principles for Natural Fibre based Geotextiles (Coir, jute, bamboo etc), Blended Geotextiles its application and case studies, Tensile and Hydro-physical properties, Estimation techniques, Application as soil saver, Effect on soil degradation properties, Factors affecting soil erosion, Rainfall erosivity and indices, Wischmeir's equation for its prediction, isoerodent map of India, Soil erodibility and its measurement, Method of soil loss estimation and measurement (USLE and RUSLE), Water erosion prediction programme (WEPP), sediment transport equations, runoff measurement, sediment measurement (multislot divisor), Concept of integrated watershed management and role of RS and GIS, Bioengineering, Role of jute, coir and bamboo based geotextile in soil conservation, Reinforcement, Biodegradability, Life cycle and environmental impact, Economic evaluation.

Natural Fibre based sustainable packaging for Agricultural/Horticultural produce: Overview of the packaging industry and current packaging materials, Principle behind packaging of perishable crop produce, Characteristics and properties of natural fibers suitable for packaging, Natural fibre based Green composite and their role in packaging, Design principles for natural fiber-based packaging, natural fibre-based reaper binder, Advantages and limitations of natural fiber-based packaging compared to synthetic alternatives, Biodegradable plastics for packaging agricultural produce. Life cycle assessment and environmental impact analysis, Government policies and regulations related to sustainable packaging.

Potential of natural fibers as a source of renewable energy: Characteristics of natural fibers and their suitability as a source of renewable energy, Methods of converting natural fibers into energy, such as combustion and gasification, Economic and environmental analysis of natural fiber-based renewable energy systems, Comparison of natural fiber-based energy systems with other renewable energy sources, Government policies and incentives related to renewable energy (Bioethanol).

Role of Natural Fibre in Organic and Soilless Farming: Overview of organic and natural farming, soilless farming, natural fibre waste, characterization of waste, different methods of compost preparation, role of fibre waste as compost, Characteristics of natural fibers and their suitability as a source of soilless media, Effect on crop yield, Biodegradability, Life cycle and environmental impact, Economic evaluation.

Practical:

Preparation of woven and nonwoven fabrics; Estimation of different mechanical and hydrophysical properties; Agro-textile field trial/experiment; Natural fibre-based Packaging; Production of energy from natural fibres

Planning of lectures		
Sr. No.	Topics to be covered in Lecture	Proposed No. of Lectures
1.	Natural Fibre based Agrotextiles, Characterization and their application.	1
2.	Overview of Agrotextile, Technical Textile, Non-woven technology, Design principles for Natural Fibre based Agrotextiles,	2
3.	Tensile and Hydro-physical properties, Estimation techniques, Application as crop mulch, Effect on soil properties, Measurement of soil hydrothermal regime, Effects on crop yield, Effects on soil moisture retention and weed population,	3
4.	Application as shade net, Biodegradability, Life cycle and environmental impact, Economic evaluation.	1
5.	Natural Fibre based Geotextiles, Characterization and their application: Overview of Geotextile in soil and water conservation, Woven technology, Design principles for Natural Fibre based Geotextiles (Coir, jute, bamboo etc), Blended Geotextiles its application and case studies,	2
6.	Tensile and Hydro-physical properties, Estimation techniques, Application as soil saver, Effect on soil degradation properties, Factors affecting soil erosion, Rainfall erosivity and indices, Wischmeir's equation for its prediction, isoerodent map of India, Soil erodibility and its measurement, Method of soil loss estimation and measurement (USLE and RUSLE), Water erosion prediction programme (WEPP), sediment transport equations, runoff measurement, sediment measurement (multislot divisor),	4
7.	Concept of integrated watershed management and role of RS and GIS, Bioengineering, Role of jute, coir and bamboo based geotextile in soil conservation, Reinforcement, Biodegradability, Life cycle and environmental impact, Economic evaluation.	2
8.	Natural Fibre based sustainable packaging for Agricultural/Horticultural produce: Overview of the packaging industry and current packaging materials, Principle behind packaging of perishable crop produce,	2
9.	Characteristics and properties of natural fibers suitable for packaging, Natural fibre based Green composite and their role in packaging, Design principles for natural fiber-based packaging, natural fibre-based reaper binder,	3
10.	Advantages and limitations of natural fiber-based packaging compared to synthetic alternatives, Biodegradable plastics for packaging agricultural produce. Life cycle assessment and environmental impact analysis, Government policies and regulations related to sustainable packaging.	3
11.	Potential of natural fibers as a source of renewable energy: Characteristics of natural fibers and their suitability as a source of renewable energy, Methods of converting natural fibers into energy, such as combustion and gasification,	2
12.	Economic and environmental analysis of natural fiber-based renewable energy systems, Comparison of natural fiber-based energy systems with	3

	other renewable energy sources, Government policies and incentives related to renewable energy (Bioethanol).	
13	Role of Natural Fibre in Organic and Soilless Farming: Overview of organic and natural farming, soilless farming, natural fibre waste, characterization of waste, different methods of compost preparation, role of fibre waste as compost,	2
14.	Characteristics of natural fibers and their suitability as a source of soilless media, Effect on crop yield, Biodegradability, Life cycle and environmental impact, Economic evaluation.	2
Total		32

Sr. No.	Topic	No. of Practicals
1.	Preparation of woven and nonwoven fabrics;	4
2.	Estimation of different mechanical and hydrophysical properties;	4
3.	Agro-textile field trial/experiment;	3
4.	Natural fibre-based Packaging;	2
5.	Production of energy from natural fibres.	3
Total		16

Suggested Readings

1. Blackburn, R. S. (Ed). 2009. Sustainable Textiles: Life Cycle and Environmental Impact. Woodhead Publishing. ISBN 978-1-84569-453-1.
2. Cheng, H. N., Byron, A. E. and Okos, M. R. (Eds). 2017. Sustainable Fiber-Based Packaging. John Wiley & Sons. ISBN: 978-1-119-17306-4.
3. Fangueiro, R. and Rana, S. (Eds). 2016. Natural Fibre Composites in Geotextiles: Design and Applications. Woodhead Publishing. ISBN: 978-0-08-100215-7
4. Hakeem, K. R., Jawaid, M., and Alothman, O. Y. (Eds). 2019. Biomass and Bioenergy: Processing and Properties. Springer. ISBN: 978-981-13-8562-2.
5. Hardin, M. R. (Ed.). 2007. Natural and Artificial Fiber Nonwoven Textiles. CRC Press. ISBN: 978-0-8493-6454-9.
6. Kozłowski, Ryszard M. (Ed). 2012. Handbook of natural fibres. Volume 2: Processing and applications. Woodhead Publishing Limited. ISBN 978-1-84569-698-6.
7. Tripathy, R.P. and Singh, H.P. (Eds). 1993. Soil Erosion and Conservation. New Age International (P) Limited, Publishers. ISBN: 81-224-0305-0

SEMESTER – 8 (Elective course)

Sr. No.	Course Name	Course No.	Credit	L	P	T
36.	Processing of Natural Fibers	PFE-8.38	3(2+1)	2	1	3

Objective

To enable the students to 1. Understand the chemical composition of natural fibres and their conversion methods 2. Understand the different mechanical and chemical processing methods of natural fibres 3. Know about the different value addition methods for natural fibres.

Theory:

Concept of spinning: Hand spinning system; Charkha spinning system; Concepts and working principles of ginning, opening, cleaning and blending.

Concept of Yarn Manufacture: cotton system, woolen system, worsted system, jute system, flax (wet) system: Blow room, Carding (Flat type and roller-clearer), Drawing machine, roving machine, Ring spinning, Rotor spinning; Modern developments in spinning; Principle of ring doubler and two-for-one twister; Fibre packing density of yarn; Yarn twist and its relation to yarn properties. Stress-strain relation, Mass irregularity.

Preparatory weaving: Winding, Warping, Sizing, beaming, drawing and denting; Weaving: Concept of weaving, Handloom, Primary and secondary motions of loom; shedding, picking, Beatup, Loom timing, Take-up and Let-off motions; Type of sheds; Tappet, dobby and jacquard Warp and weft stop motions; Warp protector motion. Shuttle loom, Shuttle-less looms, Basic designs; Basic woven fabric structure and design; Knitting: Concept of knitting, Warp knitting, weft knitting, advances in knitting; Nonwoven: Concept of nonwoven and classification of nonwoven, advances in non-woven preparation.

Basic Yarn testing: Count, Twist, tensile strength, CSP, Hairiness, Fabric testing: GSM, EPI, PPI, Tensile strength, tearing strength, Bursting strength, Crease recovery angle, Stiffness, Air permeability, Thermal conductivity; Fabric hand and comfort; Wetting and wicking; Water-vapour transmission.

Chemical composition of plant and animal fibres - Natural and added impurities; Pre-treatment of natural fibre for surface cleaning/ removing impurities – Desizing; Scouring; Degumming; Bleaching- reductive, oxidative; combined scouring and bleaching; Woollenization; Mercerization; fluorescent brightening agents; de-pigmentation; cottonisation; Carbonization, Felting of wool.

Value-addition of natural fibre by colouration- Introduction to dyes and pigments; Classification of dyes based on the source and application; Colouration of natural fibres- Direct, Acid, basic, Reactive, Vat, Sulphur, Solubilized and Natural dyes; Measurement of colour parameters; Evaluation of colour fastness against washing, light, bleaching, solvent; Dyeing machine; Dyeing of different textile forms-Hank yarn, Cone, Loose fibre, woven fabric, knitted fabrics and nonwoven fabric; Finishing: Physical, mechanical, physico-mechanical and chemical finishing; temporary and permanent finishing.

Practical:

Basic concepts of spinning; Manufacture of yarn from natural fibres; Practical on weaving and knitting; Yarn and fabric testing; Pre-treatments of natural fibres; Bleaching and dyeing of natural fibres; Finishing of natural fibres

Planning of lectures		
Sr. No.	Topics to be covered in Lecture	Proposed No. of Lectures
1.	Concept of spinning: Hand spinning system; Charkha spinning system; Concepts and working principles of ginning, opening, cleaning and	2

	blending.	
2.	Concept of Yarn Manufacture: cotton system, woolen system, worsted system, jute system, flax (wet) system: Blow room, Carding (Flat type and roller-clearer), Drawing machine, roving machine,	2
3.	Ring spinning, Rotor spinning; Modern developments in spinning; Principle of ring doubler and two-for-one twister; Fibre packing density of yarn; Yarn twist and its relation to yarn properties. Stress-strain relation, Mass irregularity.	3
4.	Preparatory weaving: Winding, Warping, Sizing, beaming, drawing and denting; Weaving: Concept of weaving, Handloom, Primary and secondary motions of loom;	2
5.	Shedding, picking, Beatup, Loom timing, Take-up and Let-off motions; Type of sheds; Tappet, dobby and jacquard Warp and weft stop motions; Warp protector motion. Shuttle loom, Shuttle-less looms, Basic designs;	3
6.	Basic woven fabric structure and design; Knitting: Concept of knitting, Warp knitting, weft knitting, advances in knitting; Nonwoven: Concept of nonwoven and classification of nonwoven, advances in non-woven preparation.	3
7.	Basic Yarn testing: Count, Twist, tensile strength, CSP, Hairiness, Fabric testing: GSM, EPI, PPI, Tensile strength, tearing strength, Bursting strength, Crease recovery angle, Stiffness, Air permeability, Thermal conductivity; Fabric hand and comfort; Wetting and wicking; Water-vapour transmission.	4
8.	Chemical composition of plant and animal fibres - Natural and added impurities; Pre-treatment of natural fibre for surface cleaning/ removing impurities – Desizing;	2
9.	Scouring; Degumming; Bleaching- reductive, oxidative; combined scouring and bleaching; Woollenization; Mercerization; fluorescent brightening agents; de-pigmentation; cottonisation; Carbonization, Felting of wool.	3
10.	Value-addition of natural fibre by colouration- Introduction to dyes and pigments; Classification of dyes based on the source and application;	2
11.	Colouration of natural fibres- Direct, Acid, basic, Reactive, Vat, Sulphur, Solubilized and Natural dyes; Measurement of colour parameters; Evaluation of colour fastness against washing, light, bleaching, solvent;	3
12.	Dyeing machine; Dyeing of different textile forms-Hank yarn, Cone, Loose fibre, woven fabric, knitted fabrics and nonwoven fabric; Finishing: Physical, mechanical, physico-mechanical and chemical finishing; temporary and permanent finishing.	3
Total		32

Sr. No.	Topic	No. of Practicals
1.	Basic concepts of spinning;	2
2.	Manufacture of yarn from natural fibres;	3
3.	Practical on weaving and knitting;	2
4.	Yarn and fabric testing;	2
5.	Pre-treatments of natural fibres;	3

6.	Bleaching and dyeing of natural fibres;.	2
7.	Finishing of natural fibres	2
Total		16

Suggested Readings

1. Booth J. E. 1996. Principles of Textile Testing: An Introduction to Physical Methods of Testing Textile Fibres, Yarns and Fabrics. 6th edn. London: Newnes Butterworths
2. Brown, R. 1978. Weaving, Spinning and Dyeing Book. London: Routledge and Kegan Paul.
3. Cegarra, J. P. and Valladperas, J. 1992. The Dyeing of Textile Manual, the Scientific Bases and the Techniques of Application. Italy: NecovaOfrito.
4. Corbman, B. P. 1983. Fibre to Fabric step by Step Weaving. 6th edn. New York: McGraw Hill.
5. David G, Sinclair, Roy, S. 1989. Giles Laboratory Course in Dyeing. 4th edn. London: Society of Dyers and Colourist.
6. Eichhorn SJ, Hearle JWS, Jaffe M, and Kikutani T. 2009. Handbook of Textile Fibre Structure: Fundamentals and Manufactured Polymer Fibres, Volume 1 in Woodhead Publishing Series in Textiles.
7. Fannin and Allen, A. 1979. Handloom Weaving Technology. New York: Van Nostrand Reinhold.
8. Jarman, C. 1998. Plant Fibre Processing: A Handbook. eBook 9781780442990, pp.64
9. Ponting, K. G. 1981. A Dictionary of Dyes and Dyeing. London: Bell and Hymen Ltd. Rouette,
10. H. K. 2001. Encyclopaedia of Textile Finishes. Berlin: Springer Verlag.
11. Saville, B. P. 1999. Physical Testing of Textiles. Woodhead publication. CRC Press.
12. Shenai, V. A. 1985. Technology of Dyeing: Technology of Textile Processing. Vol. VI. Sevak Publication.
13. Shenai, V. A. 1985. Technology of Printing: Technology of Textile Processing. Vol. IV. Sevak Publication.

SEMESTER – 8 (ELECTIVE)

Sr. No.	Course Name	Course No.	Credit	L	P	T
37	Agricultural Marketing and Trade	MDC-III	3(2+1)	2	1	3

Objective

1. To understand the fundamentals of agricultural marketing and trade.
2. To analyze the factors influencing supply and demand in agricultural markets.
3. To explore different marketing channels and strategies in agriculture.
4. To examine the role of government policies and regulations in agricultural markets.

Theory

Agricultural Marketing: Concepts and definitions of market, marketing, agricultural marketing, market structure, marketing mix and market segmentation, classification and characteristics of agricultural markets; demand, supply and producer's surplus of agri commodities: nature and determinants of demand and supply of farm products, producer's surplus – meaning and its types, marketable and marketed surplus, factors affecting marketable surplus of agri- commodities; pricing and promotion strategies: pricing considerations and approaches – cost based and competition based pricing; market promotion – advertising, personal selling, sales promotion and publicity – meaning, merits and demerits; marketing process and functions: Marketing process concentration, dispersion and equalization; exchange functions – buying and selling; physical functions – storage, transport and processing; facilitating functions – packaging, branding, grading, quality control and labelling (Agmark); Market functionaries and marketing channels: Types and importance of agencies involved in agricultural marketing; meaning and definition of marketing channel; number of channel levels; marketing channels for different farm products; Integration, efficiency, costs and price spread: Meaning, definition and types of market integration; marketing efficiency; marketing costs, margins and price spread; factors affecting cost of marketing; reasons for higher marketing costs of farm commodities; ways of reducing marketing costs; Role of Govt. in agricultural marketing: Public sector institutions- CWC, SWC, FCI, CACP & DMI – their objectives and functions; cooperative marketing in India; Risk in marketing: Types of risk in marketing; speculation & hedging; an overview of futures trading; Agricultural prices and policy: Meaning and functions of price; administered prices; need for innovations in agricultural price policy; Trade: Concept of International Trade and its need, theories of absolute and comparative advantage. Present status and prospects of international trade in agri-commodities; WTO; Agreement on Agriculture (AoA) and its implications on Indian agriculture; IPR. Role of government in agricultural marketing. Role of APMC and its relevance in the present day context.

Practical

Plotting and study of demand and supply curves and calculation of elasticities; Study of relationship between market arrivals and prices of some selected commodities; Computation of marketable and marketed surplus of important commodities; Study of price behaviour over time for some selected commodities; Construction of index numbers; Visit to a local market to study various marketing functions performed by different agencies, identification of marketing channels for selected commodity, collection of data regarding marketing costs, margins and price spread and presentation of report in the class; Visit to market institutions –NAFED, SWC, CWC, cooperative marketing society, etc. to study their organization and functioning. Application of principles of comparative advantage of international trade.

Planning of Lectures		
Sr. No	Topics to be covered in lecture	Proposed No. of Lectures
1.	Agricultural Marketing: Concepts and definitions of market, marketing, agricultural marketing, market structure, marketing mix and market segmentation, classification and characteristics of agricultural markets	3
2.	Demand, supply and producer's surplus of agri commodities: nature and determinants of demand and supply of farm products, producer's surplus – meaning and its types, marketable and marketed surplus, factors affecting marketable surplus of agri- commodities	3
3.	Pricing and promotion strategies: pricing considerations and approaches –	4

	cost based and competition based pricing; market promotion – advertising, personal selling, sales promotion and publicity – meaning, merits and demerits; marketing process and functions: Marketing process concentration, dispersion and equalization; exchange functions – buying and selling; physical functions – storage, transport and processing	
4.	Facilitating functions – packaging, branding, grading, quality control and labelling (Agmark)	3
5.	Market functionaries and marketing channels: Types and importance of agencies involved in agricultural marketing; meaning and definition of marketing channel; number of channel levels; marketing channels for different farm products	3
6.	Integration, efficiency, costs and price spread: Meaning, definition and types of market integration; marketing efficiency, marketing costs, margins and price spread	4
7.	Factors affecting cost of marketing; reasons for higher marketing costs of farm commodities; ways of reducing marketing costs; Role of Govt. in agricultural marketing: Public sector institutions- CWC, SWC, FCI, CACP & DMI – their objectives and functions; cooperative marketing in India	3
8.	Risk in marketing: Types of risk in marketing; speculation & hedging; an overview of futures trading; Agricultural prices and policy: Meaning and functions of price; administered prices; need for innovations in agricultural price policy	4
9.	Trade: Concept of International Trade and its need, theories of absolute and comparative advantage. Present status and prospects of international trade in agri-commodities, WTO; Agreement on Agriculture (AoA) and its implications on Indian agriculture	4
10.	IPR. Role of government in agricultural marketing. Role of APMC and its relevance in the present day context	3
Total		34

Planning of Practical		
Sr. No	Topics to be covered in lecture	No. of Practical
1.	Plotting and study of demand and supply curves and calculation of elasticities	2
2.	Study of relationship between market arrivals and prices of some selected commodities	2
3.	Computation of marketable and marketed surplus of important commodities	2
4.	Study of price behaviour over time for some selected commodities; Construction of index numbers	2
5.	Visit to a local market to study various marketing functions performed by different agencies, identification of marketing channels for selected commodity, collection of data regarding marketing costs, margins and price spread and presentation of report in the class	3
6.	Visit to market institutions –NAFED, SWC, CWC, cooperative marketing society, etc.	2
7.	Study their organization and functioning. Application of principles of comparative advantage of international trade.	3
Total		16

Suggested Reading

1. Acharya, S.S. and Agarwal, N.L., 2006, Agricultural Marketing in India, Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
2. Chinna, S.S., 2005, Agricultural Economics and Indian Agriculture. Kalyani Pub, N Delhi.
3. Dominic Salvatore, Micro Economic Theory
4. Kohls Richard, L. and Uhl Josheph, N., 2002, Marketing of Agricultural Products, Prentice-Hall of India Private Ltd., New Delhi.
5. Kotler and Armstrong, 2005, Principles of Marketing, Pearson Prentice-Hall.
6. Lekhi, R. K. and Jogindr Singh, 2006, Agricultural Economics. Kalyani Publishers, Delhi.
7. Memoria, C.B., Joshi, R.L. and Mulla, N.I., 2003, Principles and Practice of Marketing in India, Kitab Mahal, New Delhi.
8. Pandey Mukesh and Tewari, Deepali, 2004, Rural and Agricultural Marketing, International Book Distributing Co. Ltd, New Delhi.
9. Sharma, R., 2005, Export Management, Laxmi Narain Agarwal, Agra.