COLLEGE OF AGRICULTURAL ENGINEERING AND TECHNOLOGY

NAVSARI AGRICULTURAL UNIVERSITY, DEDIAPADA

-: CURRICULA & SYLLABI:-
2017-18

B.TECH.(AGRICULTURAL ENGINEERING)

FIFTH DEANS' COMMITTEE REPORT

AGRICULTURAL EDUCATION DIVISION
INDIAN COUNCIL OF AGRICULTURAL RESEARCH
KRISHI ANUSANDHAN BHAWAN-II
PUSA, NEW DELHI - 110012

CONTENTS

EXECUTIVE SUMMARY

The Indian Council of Agricultural Research (ICAR) an autonomous organisation under the Department of Agricultural Research and Education (DARE), Ministry of Agriculture and Farmers Welfare, Government of India is the largest national agricultural systems in the world. With **101 ICAR institutes** and **73 agricultural universities** spread across the country, ICAR is the apex body for co-ordinating, guiding and managing research and education in agriculture in the entire country in association with the Education Division.

The Education Division undertakes planning, development, coordination and quality assurance in higher agricultural education in the country and, thus, strives for maintaining and upgrading quality and relevance of higher agricultural education through partnership and efforts of the components of the ICAR-Agricultural Universities (AUs) System comprising State Agricultural Universities (SAUs), Deemed to be Universities (DUs), Central Agricultural Universities (CAU) and Central Universities (CUs) with Agriculture Faculty.

Quality assurance in higher agricultural education in the country has been achieved through policy support, accreditation, framing of minimum standards for higher agricultural education, academic regulation, personnel policies, review of course curricula and delivery systems, development support for creating/strengthening infrastructure and facilities, improvement of faculty competence and admission of students through All India competitions.

As first and most important step for quality improvement of education, the Indian Council of Agricultural Research has been periodically appointing Deans Committees for revision of course curriculum. In the series, Fifth Deans Committee was constituted and given terms of reference considering contemporary challenges for employability of passing out graduates and to adopt a holistic approach for quality assurance in agricultural education.

Considering the fact that the report of the Committee needs to be widely accepted, a bottom up approach in respect of curriculum development has been undertaken. To achieve this, inputs from different stakeholders of agricultural education have been obtained at different levels. The committee first deliberated on the skills which graduates must and then reverse engineering done to design course curriculum. The Committee identified Conveners/Co-conveners and given them the responsibility to have inputs from all the Deans of all the colleges of their disciplines based on the suggestions received from their faculty after holding meetings at University/College level. The suggestions received for all the disciplines were reviewed by the Committee. The Committee has tried to make sure that the report represents a national consensus in respect of various issues that have been flagged to the Committee.The course curricula have been restructured to reorient course curricula to develop much needed skills and entrepreneurial mind-set among the graduates to take up self employment, contribute to enhanced rural livelihood and food security, sustainability of agriculture and be propeller for agricultural transformation. The major recommendations are as listed below:

NEW INITIATIVES:

1. **Student READY** (Rural and Entrepreneurship Awareness Development Yojana)

   In compliance with the Student READY programme launched by the Hon'ble Prime Minister of India on 25th July, 2015, the following components are proposed for conducting one year program in all the UG disciplines:

   - Experiential Learning
   - Rural Agriculture Work Experience

- In Plant Training/ Industrial attachment
- Hands-on training (HOT) / Skill development training
- Students Projects

The details of these components are provided in the next section.

2. **Common Courses**- It was a general consensus that students of all disciplines need to be taught the courses on the following topics. The title of the course may, however, be kept as per the feasibility of the Institute.
   1. Environmental Studies and Disaster Management
   2. Communication Skills and Personality Development
   3. Information and Communication Technology
   4. Entrepreneurship Development and Business Management
   5. Agricultural Informatics
   6. Economics and Marketing

   The details of these components are provided in the subsequent section.

3. **New Programmes** – Fifth Deans' Committee has proposed introduction of following new courses:
   - B. Tech. (Biotechnology)
   - B.Sc. (Hons) Sericulture
   - B.Sc. (Hons) Home Science rechristened as Community Science
   - B.Sc. (Hons) Food Nutrition and Dietetics

4. **DPRs for Establishment of new Colleges:**

   Fifth Deans' Committee has Developed DPRs for establishment of colleges by integrating the recommendations of Committees on Minimum Standards on Higher Agricultural Education in terms of faculty strength, land requirement, departments and infrastructure.

5. **Holistic distribution of courses:**

   The Committee has attempted to distribute courses in the following format to inculcate the Basics, Principles and Skills in a systematic way.

   I year – Basic and fundamental courses
   II Year – Principles
   III Year – Production system
   IV Year – Skill and entrepreneurship development

6. **Declaring degrees in Agricultural Sciences as professional:**

The committee strongly recommends that all degrees in the disciplines of Agricultural Sciences be declared as professional courses, which include undergraduate in:

1) Agriculture
2) Agriculture Engineering
3) Biotechnology
4) Dairy Technology
5) Fisheries
6) Food Technology
7) Forestry
8) Home Science(Community Science)
9) Horticulture
10) Sericulture

7. **Implementation of recommendations:**

The Committee strongly recommends that, to make the exercise meaningful, implementation of its recommendations should be mandatory for accreditation of academic programmes and academic institutions.

DEFINING UG & PG DEGREES FOR GENERAL MARKET NEEDS AND FOR SPECIALIST JOBS AND UNIFORMITY IN UG AND PG DEGREE NOMENCLATURE:

Considering the recommendations of the Committee to Review Essential Qualifications and Degree Nomenclature of various programmes running in Agricultural Universities under the chairmanship of Dr R B Lal and to provide distinct identity to the four year B.Sc. degree offered by SAUs over the 3 years degree being run in some colleges under general universities, the committee decided to add Honours to the degrees in Agriculture, Horticulture, Sericulture, Forestry and Home Science. The degrees in Agricultural Engineering, Food Technology, Dairy Technology and Biotechnology have been proposed to be named as B. Tech with name of discipline as suffix. The degree in Fisheries Science be named as B.F.Sc.

The Masters and Doctoral degrees will be named as M.Sc /M.Tech and Ph. D with name of the department/field of specialization as suffix.

RESTRUCTURING OF UG PROGRAMMES FOR INCREASED PRACTICAL/PRACTICE CONTENTS

After detailed deliberations the committee decided to increase the practical content in the courses where ever necessary. It was decided to restrict the maximum number of credit hours in a semester to 21 -22 in order to provide time for library consultation and other activities like assignments, seminars and project preparation etc. The total number of credit hours in 8 semesters including Student READY programme will range between 170 to 183 for all the programmes.

Due to regional needs, the Fifth Deans' Committee has recommended offering certain optional courses. Many new courses have been recommended to be introduced in emerging fields like GIS, Precision farming, Conservation Agriculture, Secondary Agriculture, Hi-tech Cultivation, Speciality Agriculture, Renewable Energy, Artificial Intelligence, Mechatronics, Plastics in Agriculture, Dry land Horticulture, Introductory nanotechnology, Agro-meteorology and Climate Change, Waste disposal &Pollution abatement, Food Plant Regulations and Licensing, Food Quality, Safety Standards and Certification, Food Storage Engineering, Food Plant Sanitation and Environmental Control, EmergingFood Processing Technologies etc.

The Committee has also recommended to include Courses on Yoga Practices and Human Values & Ethics in the list of non-credit courses.

CENTRAL ASSISTANCE FOR STRENGTHENING OF HIGHER AGRICULTURAL EDUCATION

The Indian Council of Agricultural Research provides financial assistance to State Agricultural Universities (SAUs), Deemed to be Universities (DUs), Central Agricultural Universities (CAUs) and Central Universities (CUs) with Agriculture Facultyfor strengthening and development of higher agricultural education system.

The Fifth Deans' Committee has recommended continuation support for faculty & student amenities, curriculum delivery, development of facilities for UG Practicals, computer Labs, updation of professional/technical competence of para-professional

staff/administrative staff, students study & educational tours, support to deans, library strengthening and skill development. To address the inadequate

The Committee has recommended tointroduce ICAR funded **'Student Exchange Programme'**, between colleges located in different agro-climatic zones, to promote skill development in the graduating students for specialized jobs in view of market needs and demands. The Committee has also recommended additional funds to support the colleges for strengthening / expansion of existing ELP units and to create more number of additional ELP units to accommodate more number of students round the year.

The Committee has further recommended that each college should have a **Demonstration cum Production Centre** for training students, field workers of Government Departments and NGOs community leaders, in income generation skills.

GUIDELINES FOR ASSESSING TRAINING NEEDS AND PERFORMANCE OF TEACHING FACULTIES

Considering the fact that teaching faculty comprises of one of the most important pillars of the university education system besides infra structure and course curricula, the quality of faculty cannot be underestimated when aiming for quality assurance. The Fifth Deans' Committee has thus, recommended that the need of competent and updated faculty should be taken as most important issue and be addressed on priority. The Committee, therefore, has recommended that besides Assistant Professors for whom two trainings are a requisite for assessment and promotion to higher grade, at least one such training be made mandatory for other levels also like - Associate Professor, Heads and Professors, Deans of Colleges and Directors, Vice-Chancellors and Directors of DUs, every five year.

Various trainings have been organized by ICAR, such as, induction training for scientists at entry level, overseas training for global exposure in key emerging areas and structured trainings for Heads of the departments, comptrollers, faculty, technical and financial staff, pertaining to their specific needs. The Fifth Deans' Committee has recommended for increasing the number of overseas trainings so as to keep pace with the time, identifying more areas and more programmes for training at winter/summer schools, etc. Further, the committee strongly recommends conduct of training programmes under CAFT exclusively on the new subjects/ courses included in the report, for the benefit of the faculty in SAUs. A separate training programme for the nodal officer /coordinator of Student READY is recommended for efficient execution of the programme.

REFORMS IN GOVERNANCE OF SAUs

With an objective to have uniformity in the governance of State Agricultural Universities, ICAR brought out first Model Act in 1966 and has been revising it from time to time. The last revision was made by the Council in 2009.This Model Act has been formulated by ICAR to bring uniformity in functioning of all agriculture universities /institutes. The Fifth Deans Committee has recommended adoption of the provisions of ICAR Model Act, to the extent possible, by all the SAUs.

PREPARATION OF DPR FOR ESTABLISHMENT OF A NEW COLLEGE

ICAR had constituted committees for preparation of Minimum Standards for Higher Agricultural Education for different disciplines of Agricultural Sciences. The Deans' Committee considered the reports of the committees to prepare norms ans standards for establishment of a new college of the discipline.

NEW INITIATIVES PROPOSED BY FIFTH DEANS' COMMITTEE

I. Student READY (Rural and Entrepreneurship Awareness Development Yojana)

To reorient graduates of Agriculture and allied subjects for ensuring and assuring employability and develop entrepreneurs for emerging knowledge intensive agriculture, the component envisages the introduction of the program in all the Agricultural Universities as an essential prerequisite for the award of degree to ensure hands on experience and practical training. Considering the variation in different streams of agricultural education and feasibility, the Committee proposes to include following components, which are interactive and are conceptualized for building skills in project development and execution, decision-making, individual and team coordination, approach to problem solving, accounting, quality control, marketing and resolving conflicts, etc. with end to end approach in Student READY program.

i. Experiential Learning/Hands on Training –24 weeks
ii. Skill Development Training - 24 weeks
iii. Rural Agriculture Work Experience –10 weeks
iv. In Plant Training/ Industrial attachment –10 weeks
v. Students Projects - 10 weeks

The students will be required to have any three of the five components listed above depending on the requirement of their graduate education but it should be implemented for the complete year, so that their education upto level of III year may get right information in IV year and finally they should attend right stage of entrepreneurship.

II. Introduction of common courses in all agriculture disciplines

The Fifth Deans Committee is of the opinion that some of the courses like Environmental Studies & Disaster Management, Communication Skills & Personality Development, Information & Communication Technology, Entrepreneurship Development & Business Management, Agri-Informatics and Economics and Marketing need to be taught in all the undergraduate programmes of agricultural sciences, as these are must for personality development and to deal with the unforeseen circumstances.

III. Introduction of new degree programs

Since Biotechnology has become an important subject in the field of agricultural sciences, the Committee has recommended introduction of B. Tech (Biotechnology) course in SAUs. Similarly, Sericulture being an important traditional subject, the Committee endorses its inclusion as one of the disciplines in agricultural sciences.

It has been observed that the degree in Home Sciences has been losing its importance in the recent past particularly in terms of limited employability. The Committee has recommended to rechristen the discipline of Home Science to Community Science and introduce one more new course in Food Nutrition & Dietetics under the umbrella of Home Sciences along with B.Sc.in Community Science.

IV. Development of DPRs for establishment of colleges

The Deans Committees have been listing some minimum standards/requirements for the colleges. Fifth Deans Committee has developed a comprehensive Detailed Project Report (DPR) for establishing a college for each discipline.

V. Holistic distribution of courses

The Committee has distributed the courses in a systematic way so as to teach basic courses first followed by principles and finally skill development it is planned to keep courses related to basic fundamentals in first year, theory/practicals and principles with present state of Art of Technology in second year, modern and frontier area of education in third year and Student READY programme of one year in final year.

VI. Declaring degrees in Agricultural Sciences as professional

Indian Council of Agricultural Research constituted a Committee to Review Essential Qualifications and Degree Nomenclature of various programmes running in Agricultural Universities under the chairmanship of Dr R B Lal. This Committee has recommended to consider degree in agriculture as professional. The Fifth Deans Committee endorses this view and recommends to declare all degrees in agricultural sciences as professional, like veterinary and Animal Science which include undergraduate in:

1. Agriculture
2. Agriculture Engineering
3. Biotechnology
4. Dairy Technology
5. Fisheries
6. Food Technology
7. Forestry
8. Home Science(Community Science)
9. Horticulture
10. Sericulture

VII. Making implementation of recommendations of Deans Committee mandatory

A lot of efforts are made to improve the quality of agricultural education to make it internationally competitive. Implementations of the recommendations of the Fifth Deans Committee to be made mandatory for accreditation of academic programmes and academic institutions by the National Agricultural Education Accreditation Board (NAEB).

Student READY Programme

Student READY programme was launched by the Hon'ble Prime Minister of India on 25th July, 2015

Introduction

The term **READY** refers to "Rural Entrepreneurship Awareness Development Yojana".
To reorient graduates of Agriculture and allied subjects for ensuring and assuring employability and develop entrepreneurs for emerging knowledge intensive agriculture, the component envisages the introduction of the program in all the Agricultural Universities as an essential prerequisite for the award of degree to ensure hands on experience and practical training.

Component of the programme : It is proposed to include following components in Student READY program.

i. **Experiential Learning/Hands on Training –24 weeks**
ii. **Skill Development Training - 24 weeks**
iii. **Rural Agriculture Work Experience –10 weeks**
iv. **In Plant Training/ Industrial attachment –10 weeks**
v. **Students Projects - 10 weeks**

In some disciplines where some components, say, Experiential Learning is not possible at graduate level, the students will be given Hands on Training and/or Skill Development Training, but it should be (out of these 5 components) implemented for the complete year.

All the above mentioned components are interactive and are conceptualized for building skills in project development and execution, decision-making, individual and team coordination, approach to problem solving, accounting, quality control, marketing and resolving conflicts, etc. with end to end approach.

- Experiential Learning helps the student to develop competence, capability, capacity building, acquiring skills, expertise, and confidence to start their own enterprise and turn job creators instead of job seekers. This is step forward for earning while learning concept. Experiential Learning is major step forward for High Quality Professional Competence, Practical Work Experience in Real Life Situation to Graduates, Production Oriented Courses, Production to Consumption Project working, Facilitates producing Job Providers rather than Job Seekers and Entrepreneurial Orientation.
- Rural Agriculture Work Experience also enable the students to gain rural experience giving them confidence and enhancing on farm problem solving abilities in real life situations especially in contact with farmers, growers etc.
- In-plant training for a short period of time in relevant industry to gain the knowledge and experience of the work culture. In Plant training by reputed organization either MNC's or organised sectors provide an industrial exposure to the students as well as to develop their career in the high tech industrial requirements.
- Skill development component include use of Agriculture Systems & devices for enhancing functional skill. It is expected that basic infrastructure and Experiential Learning Unit available university may help in boosting livelihood ensuring opportunity.
- Student Project is essential for students interested in higher education. Through this component, they will know how to identify research problem, experimental set up and writing report etc.

For the discipline of Dairy Technology, Food science & Technology and Agricultural engineering there will 20 weeks in-plant training in place of RAWE. The students of Veterinary science discipline will undergo six months training at hospitals.

All the components as per suitability of course i.e. Experiential Learning, Skill Development Training, Rural Agriculture Work Experience (RAWE), Internship/in-plant training and Student Projects are included in the final year of study for 2 semesters to provide entrepreneurial skills, confidence and hands on experience. There are 20 credits for Experiential Learning/Skill Development Training (24 weeks), 10 credits for RAWE (10 weeks programme) and 10 Credits for Industry Attachment/Student Project (10 weeks attachment to industry). For the students of Veterinary Science Experiential Learning is moduled as per VCI pattern.

Some of the important components of Student READY programme are given as follows:

I. Experiential Learning

a) Concept

The word 'experiential' essentially means that learning and development are achieved through personally determined experience and involvement, rather than on received teaching or training, typically in group, by observation, study of theory or hypothesis, bring in innovation or some other transfer of skills or knowledge. Experiential learning is a business curriculum-related endeavour which is interactive.

EL is for building (or reinforcing) skills in Project development and execution, decision-making, individual and team coordination, approach to problem solving, accounting, marketing and resolving conflicts, etc. The programme has end to end approach. Carefully calibrated activities move participants to explore and discover their own potential. Both activities and facilitation play a critical role in enhancing team performance.

b) Objectives

EL provides the students an excellent opportunity to develop analytical and entrepreneurial skills, and knowledge through meaningful hands on experience, confidence in their ability to design and execute project work.

The main objectives of EL are:

- To promote professional skills and knowledge through meaningful hands on experience.
- To build confidence and to work in project mode.
- To acquire enterprise management capabilities

c) Duration

The experiential learning programme will be offered for 180 days (one semester) period in the final year. As the programme is enterprise oriented, students and faculty are expected to attend the activities of the enterprise even on institutional holidays with total commitment, and without any time limit or restriction of working hours for ELP. The Experiential Learning Programme shall be run for full year by making two groups and rotating activities of the final year in two groups.

d) Attendance

The minimum attendance required for this programme is 85%. The attendance of a student will be maintained at the EL unit. The attendance particulars shall be communicated to the Chief Executive Officer (Associate Dean) by the Manager of the EL unit every week. The students will be eligible for the final evaluation of EL only when the attendance requirement is met with. Any student in the event of recording shortage of attendance has to re-register the EL when offered next by paying the assigned fee.

e) Students' Eligibility

To get the eligibility for registering the EL programme, the students should have completed all the courses successfully. No student should be allowed to take up the EL programme with backlog/repeat courses. The assignment/allotment of the EL programme shall be based on merit of the student at the end of 5th Semester. A separate certificate should be issued to the students after successful completion of EL course. Allotment of EL programmes amongst students to different modules should be done strictly on the basis of merit at the end of fifth semester. In this work experience students will know exact problems of farming &suggest appropriate technology and finally useful in enhancing productivity and profitability at farmers end.

II. Rural Agricultural Work Experience

The Rural Agricultural Work Experience (RAWE) helps the students primarily to understand the rural situations, status of Agricultural technologies adopted by farmers, prioritize the farmer's problems and to develop skills & attitude of working with farm families for overall development in rural area. The timings for RAWE can be flexible for specific regions to coincide with the main cropping season.

2. Objectives

1. To provide an opportunity to the students to understand the rural setting in relation to agriculture and allied activities.
2. To make the students familiar with socio-economic conditions of the farmers and their problems.
3. To impart diagnostic and remedial knowledge to the students relevant to real field situations through practical training.
4. To develop communication skills in students using extension teaching methods in transfer of technology.
5. To develop confidence and competence to solve agricultural problems.
6. To acquaint students with on-going extension and rural development programmes.

III. In Plant Training (IPT)

Technology and globalization are ushering an era of unprecedented change. The need and pressure for change and innovation is immense. To enrich the practical knowledge of the students, in-plant training shall be mandatory in the last semester for a period of up to 10 weeks. In this training, students will have to study a problem in industrial perspective and submit the reports to the university. Such in-plant trainings will provide an industrial exposure to the students as well as to develop their career in the high tech industrial requirements. In-Plant training is meant to correlate theory and actual practices in the industries. It is expected that sense of running an industry may be articulated in right way through this type of industrial attachment mode.

OBJECTIVES

- To expose the students to Industrial environment, which cannot be simulated in the university.
- To familiarize the students with various Materials, Machines, Processes, Products and their applications along with relevant aspects of shop management.
- To make the students understand the psychology of the workers, and approach to problems along with the practices followed at factory
- To make the students understand the scope, functions and job responsibility-ties in various departments of an organization.
- Exposure to various aspects of entrepreneurship during the programme period

The students will be required to submit the report on various aspects and will be issued certificates upon successful completion of the student READY components. It is planned that **ICAR will provide Rs. 3000/pm per student for the duration of RAWE/ In- plant Training/ Hands-on Training (HOT) / Skill Development Training subject to a maximum of 6 months.**

Fifth Deans Committee after deliberations with the Conveners/Co-conveners and Subject Matter Specialists recommend the discipline-wise Student READY programs

AGRICULTURE ENGINEERING

Student READY program of the Agricultural Engineering is proposed to have the following components:

1. Student READY Skill Development Training -I for five weeks in the summer break after IV semester with a credit load of **0+5** credit hours.
2. Student READY Skill Development Training -II for five weeks in the summer break after VI semester with a credit load of **0+5** credit hours.
3. Industrial attachment of 10 weeks in VII semester with a credit load of **0+10** credit hours.
4. On campus Experiential Learning Program of 12 weeks in VII semester with a credit load of **0+10** credit hours.
5. Project Planning and Report Writing of 12 weeks during VII semester with a weightage of **0+10** credit hours.

EVALUATION OF STUDENT READY PROGRAM

- Students shall be evaluated component-wise under village attachment/ agro-industrial attachment/ hands on training/skill development training/experiential learning/student projects.
- Each College of the University will designate a Student READY Program Coordinator and component wise evaluation committees. These committees will evolve a method of evaluation depending upon the component undertaken giving due weightage to the observations made by the Scientists/Agro-industrial Officer and the Program Coordinator with whom they are attached.
- Since the Credit Hours allotted to the Student READY program are gradial, the minimum condition of attendance and grading system will apply for the program as will be applicable to other courses.
- It is expected that at the end of Student READY program, the students should gain competency for entrepreneurship, which should be innovative and creative in nature. The evaluation committee must ensure percentage increase in this competency at the end & successful organization of all Student READY programs.

COMMON COURSES

It was a general consensus that students of all disciplines need to be taught the following courses:

I. Environmental Studies and Disaster Management (as per UGC guidelines-core module for under graduate courses of all branches of higher education)

Theory

Unit 1 : Multidisciplinary nature of environmental studies Definition, scope and importance

Unit 2: Natural Resources: Renewable and non-renewable resources. Natural resources andassociated problems.

a) Forest resources: Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forest and tribal people.

b) Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefitsh and problems.

c) Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies.

d) Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies.

e) Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources. Case studies.

f) Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification. • Role of an individual in conservation of natural resources. • Equitable use of resources for sustainable lifestyles.

Unit 3: Ecosystems • Concept of an ecosystem. • Structure and function of an ecosystem. • Producers, consumers and decomposers. • Energy flow in the ecosystem. • Ecological succession. • Food chains, food webs and ecological pyramids. • Introduction, types, characteristic features, structure and function of the following ecosystem :-

a. Forest ecosystem
b. Grassland ecosystem
c. Desert ecosystem
d. Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)

Unit 4: Biodiversity and its conservation:- Introduction, definition, genetic, species & ecosystem diversity and biogeographical classification of India.

Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values. Biodiversity at global, National and local levels, India as a mega-diversity nation.

Hot-sports of biodiversity.

Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts. Endangered and endemic species of India.

Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.

Unit 5 : 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
g. Nuclear hazards.
Solid Waste Management: causes, effects and control measures of urban and industrial wastes.
Role of an individual in prevention of pollution.
Pollution case studies.
Unit 6: Social Issues and the Environment:
From Unsustainable to Sustainable development
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. dyes.
Wasteland reclamation.
Consumerism and waste products.
Environment Protection Act.
Air (Prevention and Control of Pollution) Act.
Water (Prevention and control of Pollution) Act
Wildlife Protection Act
Forest Conservation Act
Issues involved in enforcement of environmental legislation.
Public awareness.
Unit 7: Human Population and the Environment: population growth, variation among nations, population explosion, Family Welfare Programme.
Environment and human health: Human Rights, Value Education, HIV/AIDS.
Women and Child Welfare.
Role of Information Technology in Environment and human health.
Case Studies.
Unit 8: Field work: Visit to a local area to document environmental assets river/forest/grassland/hill/mountain, visit to a local polluted site-Urban/Rural/Industrial/Agricultural, study of common plants, insects, birds and study of simple ecosystems-pond, river, hill slopes, etc.

Disaster Management

Theory

UNIT-1 :-Natural Disasters- Meaning and nature of natural disasters, their types and effects. Floods, drought, cyclone, earthquakes, landslides, avalanches, volcanic eruptions, Heat and cold waves, Climatic change: global warming, Sea level rise, ozone depletion.

UNIT-2 :-Man Made Disasters- Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire, oil fire, air pollution, water pollution, deforestation, industrial waste water pollution, road accidents, rail accidents, air accidents, sea accidents.

UNIT-3:-Disaster Management- Effect to migrate natural disaster at national and global levels. International strategy for disaster reduction. Concept of disaster management, national disaster management framework; financial arrangements; role of NGOs, community –based organizations and media. Central, state, district and local administration; Armed forces in disaster response; Disaster response; Police and other organizations.

II.

III. Communication Skills and Personality Development

Theory

Communication Skills: Structural and functional grammar; meaning and process of communication, verbal and nonverbal communication; listening and note taking, writing skills, oral presentation skills; field diary and lab record; indexing, footnote and bibliographic procedures. Reading and comprehension of general and technical articles, precise writing, summarizing, abstracting; individual and group presentations, impromptu presentation, public speaking; Group discussion. Organizing seminars and conferences.

Practical

Listening and note taking, writing skills, oral presentation skills; field diary and lab record; indexing, footnote and bibliographic procedures. Reading and comprehension of general and technical articles, precise writing, summarizing, abstracting; individual and group presentations.

IV. Information and Communication Technology

Theory

IT and its importance. IT tools, IT-enabled services and their impact on society; computer fundamentals; hardware and software; input and output devices; word and character representation; features of machine language, assembly language, high-level language and their advantages and disadvantages; principles of programming- algorithms and flowcharts; Operating systems (OS) - definition, basic concepts, introduction to WINDOWS and LINUX Operating Systems; Local area network (LAN), Wide area network(WAN), Internet and World Wide Web, HTML and IP; Introduction to MS Office - Word, Excel, Power Point. Audio visual aids - definition, advantages, classification and choice of A.V aids; cone of experience and criteria for selection and evaluation of A.V aids; video conferencing. Communication process, Berlo' s model, feedback and barriers to communication.

Practicals

Exercises on binary number system, algorithm and flow chart; MS Word; MS Excel; MS Power Point; Internet applications: Web Browsing, Creation and operation of Email account; Analysis of fisheries data using MS Excel. Handling of audio visual equipments. Planning, preparation, presentation of posters, charts, overhead transparencies and slides. Organization of an audio visual programme.

V. Entrepreneurship Development and Business Management

Theory

Concept of Entrepreneur, Entrepreneurship Development, Assessment of entrepreneurship skills, SWOT Analysis & achievement motivation, Entrepreneurial behavior, Government policy and plan for entrepreneurship development, Developing Leadership Skills, Encoding and decoding communication skills; Communication skills for entrepreneurship development, Developing Speaking Skills, Developing Listening Skills, Developing organizational skill , Developing Managerial skills, Problem solving skill, Supply chain management and Total quality management, Project Planning Formulation and report preparation.

VI. Agri-Informatics

Theory

Introduction to Computers, Operating Systems, definition and types, Applications of MS-Office for document creation & Editing, Data presentation, interpretation and graph creation, statistical analysis, mathematical expressions, Database, concepts and types, uses of DBMS in Agriculture, World Wide Web (WWW): Concepts and components.

Introduction to computer programming languages, concepts and standard input/output operations.

e-Agriculture, concepts and applications, Use of ICT in Agriculture. Computer Models for understanding plant processes. IT application for computation of water and nutrient requirement of crops, Computer-controlled devices (automated systems) for Agri-input management, Smartphone Apps in Agriculture for farm advises, market price, postharvest management etc; Geospatial technology 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 using IT tools.

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 Document. MS-EXCEL - Creating a spreadsheet, use of statistical tools, writing expressions, creating graphs, analysis of scientific data. MS-ACCESS: Creating Database, preparing queries and reports, demonstration of Agri-information system. Introduction to World Wide Web (WWW). Introduction of programming languages. Hands on Crop Simulation Models (CSM) such as DSSAT/Crop-Info/CropSyst/ Wofost; Computation of water and nutrient requirements of crop using CSM and IT tools. Introduction of Geospatial Technology for generating valuable information for Agriculture. Hands on Decision Support System. Preparation of contingent crop planning.

VII. Economics and Marketing

Theory

Economics – Terms and definitions - Consumption, Demand and Supply. Factors of production. Gross Domestic Product – Role of Poultry Sector in National GDP – Marketing- definition – Marketing Process – Need for marketing – Role of marketing — Marketing functions – Classification of markets – Marketing of various channels – Price spread – Marketing Efficiency – Integration – Constraints in marketing of agricultural produce. Market intelligence – Basic guidelines for preparation of project reports- Bank norms – Insurance – SWOT analysis – Crisis management.

Practical

Techno-economic parameters for preparation of projects. Preparation of Bankable projects for various agricultural products and its value added products. Identification of marketing channel– Calculation of Price Spread – Identification of Market Structure – Visit to different Markets.

The contents given above are suggestive. It was decided by the Committee these contents be adjusted in courses and credit hours as per their relevance to the concerned.

EXAMINATION AND EVALUATION SYSTEM

Fifth Deans' Committeedeliberated on the examination and evaluation system being followed by different universities. The Committee recommends Uniform Grading system to be followed with uniform OGPA requirements for award of degrees at all levels and uniform conversion formulae to be followed for declaration of I, II and III divisions, distinctions etc. Declaration of division in the degree certificate to be made compulsory. by all universities:

1. **Examination**
   - External theory (50%)
   - Internal Theory + Practical (50%)

➢ **Courses with Theory and Practical**
Mid-term Exam (30%) + Assignment (5%) in practical oriented courses + Practical (15%)

➢ **Courses with only Theory**
Mid-term Exam (40%) + Assignment (10%)

➢ **Courses with only Practical**:
(100%) Internal

- Paper to be set by external: HOD shall ensure the coverage of syllabus. If needed moderation can be done.
- Evaluation to be done **i**nternally by the faculty other than the Course Instructor. Syllabus of the concerned course shall be sent to the external examiner, who shall prepare the question papers. **For practical, it is recommended that examination shall be conducted by course instructor(s) and one teacher nominated by HOD.**

2. **Evaluation**

Degree	**Percentage of Marks Obtained**	**Conversion into Points**
All	100	10 Points
	90 to <100	9 to <10
	80 to <90	8 to <9
	70 to <80	7 to <8
	60 to <70	6 to <7
	50 to <60	5 to <6
	<50 (Fail)	<5
	Eg. 80.76	8.076
	43.60	4.360
	72.50 (but shortage in attendance)	Fail (1 point)

OGPA	**Division**
5.000 – 5.999	Pass
6.000 – 6.999	II division
7.000 – 7.999	I division

8.000 and above	I division with distinction

GPA = Total points scored / Total credits (for 1 semester)

CGPA = ∑ Total points scored / Course credits

OGPA = ∑ Total points scored (after excluding failure points)/ Course credits

% of Marks = OGPA x 100/10

CENTRAL ASSISTANCE FOR STRENGTHENING OF HIGHER AGRICULTURAL EDUCATION

The SAUs are autonomous bodies established by the Act of respective State Legislature and wholly funded by the State Government concerned. The ICAR supplements the State funding by releasing fund that is actually Grant-in-Aid.

The Agricultural Education Division under the aegis of Indian Council of Agricultural Research undertakes planning, development, coordination and quality assurance in higher agricultural education in India and, thus, strives for strengthening and development of higher agricultural education system through partnership and efforts of the components of the ICAR-Agricultural Universities System comprising State Agricultural Universities (SAUs), Deemed to be universities (DUs), Central Agricultural Universities (CAUs) and Central Universities (CUs) with Agriculture Faculty. The Agricultural Education Division is providing financial assistance to Agricultural Universities under the XII Plan Scheme "Strengthening and Development of Higher Agricultural Education in India"

This grant is provided for infrastructure development, gender mainstreaming including girls' hostels, other new civil works related to student amenities, including boys and international hostels, educational museums, examination halls and auditoriums, repair/ refurbishing/ renovation and modernization of educational structures etc. This also includes personality development, faculty development, strengthening of sports and games facilities, placement cells and other student amenities, building-on the agricultural education legacy by providing support to old historical universities/ colleges; equipments/ computers/ implements for higher education; strengthening of library, e-resources including existing e-courses, e-granth, ICT facilities etc. Support also includes preparation of quality instructional material, writing university level textbooks, manuals, etc. for effective teaching and learning process. The following are eligible to receive grant from Council:

- All State Agricultural Universities (including Animal Science, Fishery, and Horticulture) established by an act passed in State Legislature, and its constituent colleges from which at least one batch of students have passed out. Necessary documents related to establishment of the university and achievements must have been submitted to the Council.
- All Deemed to be Universities of ICAR, Central Agricultural Universities, Central Universities with agricultural faculty involved in teaching and research in agricultural sciences and have been established by an act of either the State Legislature or the Parliament and recognized by the UGC.
- Deemed to be Universities duly recognized by Government of India and admit students as per guidelines of ICAR through AIEEA.

During the early phase of SAUs' establishment, funding from Centre and State was fairly adequate for development of infrastructure including laboratory facilities, equipment, libraries and research farms. Up to VI Plan, almost 33 percent of the ICAR budget was devoted to strengthening of agricultural education in the country and this is the major reason that most of the Universities established during that period have excellent infrastructure, which is largely contributed by the ICAR. The share of agricultural education in ICAR budget was 8.9% in VIII Plan, which increased to 14 % in X Plan and further to 21.5% in XI Plan. In absolute figures, it has increased from Rs. 224.69 crores in the IX Plan to Rs. 2900.00 crores in the XII Plan. However, with time, the number of universities and their constituent colleges and departments have increased

but the budgetary provisions could not be increased commensurately. Sectoral division of SAUs into different subject areas has also contributed to their rising number and falling financial share. Consequently, the financial health of SAUs, in general, is precarious. It is imperative to enhance budgetary support both at the Centre and the State level to attain and sustain enhanced capacity for technology development and quality of research and education.

In this backdrop, it seems imperative to enhance central/state assistance to agricultural universities for strengthening of Higher Agricultural Education in the country. In this context, following key components are being proposed for providing central assistance to agricultural universities and their constituent colleges for imparting quality and relevant skill-based education.

Civil Work: Support should be provided for repair, renovation, modernization and furnishing of academic infrastructure, student hostels, electrification and road network. Following specific support for new construction is recommended:

(i) **Student Hostels:** For construction of Girls, Boys and International Hostels, Council has a provision to provide grant of maximum of Rs. 250.00 lakh for NEH region/difficult terrains, and Rs. 200.00 lakh for other areas. Priority is given for the construction of Girls Hostel as per actual need of the university.

In the last couple of decades in most of the universities, there has been welcome change in respect of student enrolment. Moreover, most of the state governments now have provided for reservation of the girl students in Agricultural Sciences. One of the major difficulties for students in pursuing higher studies in agricultural sciences is the lack of availability of residential accommodation.

With the increasing number of students coming to agricultural sciences, it is necessary that adequate infrastructure is built for residential accommodation. The Committee is of the view that, additional Boys Hostel and Girls Hostel required, if any, as per the number of students enrolled may be funded by the ICAR/State Govts. making an adequate provision as per the estimated expenditure.

(ii) **Class Rooms and Examination Halls:** Support for development of Examination Hall subject to a maximumof Rs. 100 lakh per examination hall is being provided by the Council. There is also a provision to provide a special grant up to a maximum of Rs. 20.0 lakh per university per year for the establishment of Smart Class Rooms consisting interactive board, touch screen, bio-matrix, visualized, e-kiosks and Artificial Intelligence (AI) based course modules, etc.

It is observed that in many universities the number of seats at undergraduate and postgraduate levels has increased over time. Although new buildings particularly class rooms and examination halls have been constructed but still they are inadequate to cater to the present day requirements. It is, therefore, necessary that requisite infrastructure is constructed to run academic programmes effectively. In view of this, adequate financial support from ICAR/State Govt. as per the estimated expenditure is proposed.

(iii) **International Hostel:** The ICAR provides support for International Hostels subject to the condition that no support under this head has been provided to the university earlier and international students are regularly enrolled in sufficient number. The committee proposes to continue such support keeping in view the number of students seeking admission in SAUs.

(iv) **Faculty & Student Amenities:** Councilprovides a support ofRs. 200/- per student for managing campus interviews and other related welfare activities in the colleges and hostels including games, sports & cultural activities and health-care facilities with a maximum limit of Rs. 5.00 lakh per university. Support of

Rs.50.00 lakhs or actualexpenditure, whichever is less, is also provided for each event like AgriUnifest/ AgriSports/ Education Olympiad per year to organize the event. Funds are also provided, based on merit of the case, for facultyrelated activities such as games, cultural, literary activities and special lectures of common interest with a maximum limit of Rs. 5.0 lakh per university. Need based support for strengthening of existing sports facilities is also provided subject to a maximum of Rs. 50.00 lakh per AU.

The Committee proposes to continue such need based supports.

(v) **Electrification and Road Network:** It is observed that all SAUs although have access to electricity but suffer from serious deficiency in electricity supply on account of poor electric infrastructure. Similarly, many universities are having a poor road network infrastructure. It is, therefore, necessary that existing electric and road infrastructure should be improved and new infrastructure in this regard be taken up on priority basis. The Committee is of the view that the concerned State Governments should provide funds for creation and maintenance of such facilities.

(vi) **Repairs and Renovation:** The SAUs have created facilities of boys and girls hostels, laboratory and other buildings with ICAR support. Some of them are quite old and need to be modernized. Limited need based support subject to maximum ceiling of Rs.500.00lakh per university is being provided by the Council for refurbishing, renovation, repair, and maintenance of existing structures viz. Hostels and Academic Blocks, International Hostel, Museum, Sports Complex, Examination Hall and other structures related to teaching and learning activities. Such support is recommended to be continued.

(vii) **Old/Historical College:** The ICAR provides amaximum amount of Rs. 500.00 lakh each for more than 100 years old; Rs. 250.00 lakh each for 50 to 99 years old and Rs. 100.00 lakh each for 25 to 49 years old colleges in order to maintain/protect thse old and historical colleges, as per the availability of funds. The support is recommended to be continued.

(viii) **Up-gradation/Replacement of Facilities, including Equipments:** Need based support is being provided by the Council for replacement/ up-gradation of facilities/ equipment for teaching and practical, which are either outdated or have lived their life and are required to be urgently replaced to impart quality education. Support is recommended to be continued.

(ix) **Annual Maintenance Contracts (AMCs), Replacement of Old and Obsolete Equipments and Parts thereof:** For further strengthening research and teaching need based support notexceeding Rs. 25.00 lakh per AU per year is being provided for AMC and replacement purpose. Support is recommended to be continued.

(x) **Curriculum Development and Delivery:**

The ICAR is providing a support of Rs. 50,000/- per college for preparation of Textbooks, practical manuals and computer-led instructional material. Support is also being provided to meet day-to-day needs forconduct of practicals including consumable, glassware and experimental material etc., at the rate of Rs. 3000/- per UG student and of Rs. 5000/- per PG student. Such grants are recommended to be continued and amount be revised from time to time as upgradation of these facilities is must to keep pace with the current scenario.

(xi) **Strengthening of UG & PG Teaching:** Participation of faculty inscientific meetings, enables them to keep abreast of latest developments in science and educational reforms and helps in building confidence while making presentations and designing teaching materials for classroom discussions and practical sessions.

A support to the tune of maximum Rs. 50 lakh per university is being provided by the Council for this purpose. University can utilize a maximum of 25% of grants allocated under this head for deputing faculty at National Symposium/ Workshop/ Seminar/ meetings; and Specific National level trainings in emerging areas respectively. Such type of activities are must and need to be funded continuously.

(xii) Development of Facilities for UG Practicals, Computer Labs: Strengthening of the laboratories including computer to keep the labs equipped with the latest equipments for smooth conduct of practicals is must. The grant to a maximumceiling of Rs. 20.0 lakh per AU per year is being provided by the Council.

(xiii) Updation of professional/technical competence of para-professional - staff/administrative staff: ICAR, provides a grant to a maximum ceiling of Rs. 10.0 lakh per university per year forupdating professional/technical competence of para-professional staff/administrative staff. This support is being provided for the purpose of training 10% of the staff every year in skills related to his/ her job performance, preferably in the form of group trainings. The support is recommended to be continued.

(xiv) Students Study & Educational Tours: Studentstudy and educational tours to well-known institutions and organizations and interactions with their faculty help students broaden their knowledge and skills. There is a provision for a support of Rs. 5000/- to eachstudent once in degree course for educational tours subject to a maximum support of Rs. 15.0 lakh per university. The Committee is of the view that support should continue to be provided based on actual number of students.

(xv) Support to Dean: Committee members were of the view that the grant-in aid released by the Council goes to the Vice-chancellor and all Deans may not get the due share, hence suggested that grant be released to the Deans of colleges. Education Division officials informed that looking into the large number of constituent colleges it will not be practically possible. However, a provision to a maximum ceiling of Rs. 5.0 lakh per college in universityhas been kept to carry out following activities:

- Support in order to introduce innovative teaching techniques and carrying out creative activities in the college for overall welfare of staff and students.
- Support to meet part ofthe expenditure for conducting examinations and strengthening of examination cell.
- Support for assisting faculty with special grant to strengthen learning, particularly in conduct of practicals or research by the students.
- Support for existing e-resources including **NISAGENET** and **e-Courses**.

(xv) Library Strengthening

The libraries of the agricultural universities and its constituent colleges have to be strengthened to enhance their learning resources including writing of text books and preparation of quality instructional material, e-learning resources and infrastructure. Financial support need to be considered for strengthening and modernization of libraries including networking for online access to literature for ensuring equity and availability of quality learning resources both in the main campuses and off-campus colleges for the benefit of students and teachers, e-learning tools, modules and networking and overall library strengthening along with promotion of ICT connectivity, video conferencing and Technology Enhanced learning (TEL). The aim is to develop a unique virtual digital library of NARS accessible globally.

The ICAR provides a sum of maximum Rs. 25.00 lakh per college and Rs. 30.00 lakh for university library for strengthening of existing library. The proposals for existing programme viz., e-Granth, to be considered separately with a maximum

ceiling of Rs. 30.00 lakh per year in the XII Plan. The fund are allocated under the following head under the sub-components "Library Strengthening".

(a) Essentially to convert existing library into digital library for books issue, deposition, maintaining text, reference, and book bank etc.
(b) Procurement of books from international publishers and e-resources related to subject matter.
(c) Repair and renovations of old library and equipping them with new shelves, Air Conditioners, De-humidifier, illumination shields, comfort seating zone and e-Kiosks for assessing facilities.
(d) Digitization of already available books/references/CD ROMS, etc.
(e) Strengthening of digital library and ICT tools, annual maintenance of equipments installed in library, strengthen/installation of security system, purchase of fire extinguishers, establishment of Wi-Fi zone in the library.

(xvi) Skill development

a) Experiential Learning: In the revised syllabus, more emphasis on experiential learning has been laid. This is a major structural change undertaken for bringing professionalism and practical work experience in real life situations to graduates. These programmes will build confidence, facilitate skill development through experiential learning and facilitate in producing job providers rather than job seekers. Modification in course curriculum necessitates change in methodology in teaching and learning and development of facilities like model farms, dairy plants, food processing facilities, workshops, procurement of state of the art equipments for practical training, ICT facilities, etc. The proposed budgetary outlay of Rs. 175.00 crores has been kept in XII Plan for setting up of EL modules across the universities.

b) RAWE/ In-plant training: For this important activity, students need to be provided stipend as they have to mostly live outside and have to incur expenditure. It is proposed that a provision of Rs. 3000 per student/month during RAWE/Implant training or Internship of Veterinary graduates. Of the ICAR share of Rs. 3000, Rs. 2500 would go as stipend to the student and Rs. 500 towards operationalizing of the programme (*meeting faculty expenses, contingency expenses POL, medicines during clinic etc*)

(xvii) Human Resources Development

a) Centres of Advanced Faculty Training (CAFT): Centers of Advanced Faculty Training were created for undertaking discipline oriented advanced training for teaching, research and extensions in emerging areas and also training and retraining of faculties/scientist of other ICAR Institutes/AUs in enhancing their capabilities in use of educational innovations, modern teaching and research methodologies along with serving as repository of ideas and information in concerned discipline/department. In the XI Plan, 31 such centers were functioning and until now all the CAFTs were actively organizing atleast one training programme of 21 days duration annually and about 3400 faculty and scientists participated in these programme, which resulted in acquisition of desired skills and knowledge in emerging areas. It is proposed to further strengthen these centers in view of their major outcome and also creation of new CAFTs in areas like Bioinformatics and Statistics, Genetic resource management and Nanotechnology, Biotechnology (Animal/Plant), Computational biology, Climate change, Food Processing, Organic Farming Agriculture trade and management, Veterinary Pathology and ICT and thus taking their number to 40. The mandate of CAFTs is recommended to also include long-term customized training and benefit of CAFTs trainings may also be extended

beyond ICAR institutes/AUs on payment basis. Education Division, ICAR has kept a provision of budgetary support of Rs. 25.0 crore is proposed with a minimum of Rs. 15.0 lakh for each CAFT per year during XII Plan.

b) **Faculty Exchange/Guest & Adjunct faculty:** In order to address faculty shortage especially in cutting edge areas, outstanding performing scientists/academicians from public and private R & D institutions with academic and research credentials are proposed to be made eligible for appointment as Adjunct Faculty in a university department. Professionals and specialists from public sector units and business corporations, and innovative farmers will also be eligible for these positions. A budgetary provision of Rs. 20.0 crorehas been made for this programme in XII Plan.

c) **ICAR International Fellowships:** With the objective to develop competent human resource and showcasing the strength of Indian ICAR-AUs system, ICAR International Fellowships were introduced in 2009-10, for pursuing Ph.D. programme at Indian agricultural universities (AUs) and the overseas universities for both overseas and Indian candidates. The objective is to develop competent human resource that are trained in best laboratories in the world (for Indian candidates) and expose overseas candidates to top rated Indian AUs for facilitating future cooperation with these countries. To continue the scheme a budget outlay of Rs. 30.00 crore has been kept in XII Plan.

d) **ICAR Emeritus Scientist:** This on-going activity facilitates outstanding scientists to complete the nationally important research already being undertaken at the time of their superannuation. The programme has helped to make use of the experience of retired professionals for remedying manpower imbalances in some of the crucial areas of research. It is proposed that this initiative may be used not only to primarily complete the on-going research projects but also initiating a new programme in nationally important priority areas for a period of three years. This would ensure a structured outcome from the outstanding superannuated faculty/scientists. The existing slots of 50 (in XI Plan) has been increased to 100 (in XII Plan)

e) **ICAR Emeritus Professor:** Quality of education in most of the universities is adversely affected due to shortage of faculty, little opportunities for faculty development and aging/superannuating faculty. Only 65% of the sanctioned faculty strength remains filled, and over 50% universities have over 30% vacant faculty positions. The ICAR Emeritus Professor program started in XII Plan will be a new initiative of tapping Brain and Skill Bank of the outstanding superannuated professionals of NARS by utilizing their talent in teaching courses and other related activities, student research guidance and developing instructional material/ Text Books including e-learning resources for use in national agricultural education programme and distance education in the field of agriculture, veterinary science & animal husbandry, fisheries, home science, dairy technology and allied sciences.The Scheme is open to the scientists/teachers of the level of Principal Scientist/Professor and above from National Agricultural Research System that includes AUs and ICAR institutes engaged in Agricultural Research, Education, Human Resource Development and Extension.

(xviii) **National Talent Scholarship for UG and PG Students:** The NTS awards, @ Rs.2000 per month, are presently given to students on the basis of qualifying the ICAR's All India Entrance Examination or Veterinary Council of India Examination for Under graduate degree programme in Agricultural / Veterinary science subjects and subsequent admission in Agricultural University/ Institute outside the State of Domicile of the candidate. This has changed the cultural life on campuses, brought

healthy competition, promoted national integration, leading to improvement in instruction. The NTS awards have, in XII Plan, been extended to Post graduate programme as well to students selected on the basis of qualifying the ICAR's All India Entrance Examination for Post-graduate degree programme in Agriculture and allied science subjects and subsequent admission in Agricultural University/ Institute outside the State of Domicile of the candidate. PG students are given NTS @ of Rs. 3000 per month.

The committee appreciates the efforts of ICAR towards improvement of Higher Agricultural Education and recommends to continue further.

GUIDELINES FOR ASSESSING TRAINING NEEDS AND PERFORMANCE OF TEACHING FACULTIES

A massive exercise has been done by the Fourth Deans Committee to develop guidelines for assessing training needs and performance of teaching facilities. The quality of agricultural education is governed by faculty, infrastructure and curricula. Today we are in jet age and with rapid developments in science and technology especially cutting edge technologies, the technology gap is widening, hence to maintain quality of faculty its continuous updation is must. At present most of the Universities have extensive inbreeding which is one of the important factors contributing to poor quality of graduates. Although the State Agricultural Universities were established on land grant pattern requiring integration of teaching, research and extension education, but the integration is almost negligible. The faculty strength in most of the SAUs is dwindled in the recent past. The state governments are required to make provision for adequate funds for knowledge updation of faculty in structured manner, so as to assure quality of education in SAUs.

Indian Council of Agricultural Research for the last many years have been insisting for making provision for training of each faculty once in five years nationally facilitating these trainings through increased number of summer schools, winter schools and training programmes conducted by the Centers of Advance Studies (CAS) and Niche Area of Excellence (NAOE). The quality of trainings provided at NAOE and CAS have been of first rate in many of the new and emerging areas because ICAR provided enough funds initially for purchase of state of the art equipments and necessary budget for training. Assistant Professors were the most benefitted because of the requirement of two training programmes for assessment and promotion to higher grade. The committee was of the view that such requirements be made essential for higher level of scientists and managers so that the aim of updation in competence of senior faculty is achieved.

Faculty is required to be abreast with current developments, and have adequate knowledge and expertise in cutting edge technologies, it is, therefore, in the interest of the concerned organizations, to have a structured mechanism for career development of faculty through need assessed regular training at different levels for improving quality of education. This will facilitate providing knowledge and expertise to our graduates in real life situations. The Committee, therefore, recommends that realizing the ICAR goal, at least one training every five year be made mandatory with the following duration of courses at different levels.

- Associate Professor: 10-14 day programme
- Heads and Professors: 7 day programme
- Deans of Colleges and Directors: 3-5 day programme on management
- Vice-Chancellors and Directors of DUs: Retreat for two days

b. *Induction training:*

ICAR has been organizing induction training for scientists at initial entry level and this has been appreciated by all. Similar induction trainings need to be built-in the SAUs for a period of 3-4 months with a focus on pedagogy, computer literacy, knowledge about national and international agriculture, curriculum development, financial and administrative rules and procedures, etc.

c. *Training overseas:*

In key emerging areas such as biotechnology, processing and value addition, GIS, remote sensing, IPM, INM, agribusiness management, diagnostics, IPR, specialty foods, packaging, international quality standards, exports, entrepreneurship development, etc., faculty needs to be trained at best of the

institutions globally. It is recommended that as an institutional goal ten per cent of the faculty be sent for training overseas every year for a period ranging from three months to one year depending upon the area and the time required for necessary skill acquisition. The trainings also need to be provided to ICAR scientists since the Committee has recommended linkage of SAUs with at least one ICAR institute and vice-versa. Since knowledge and qualification of teachers holds the key for quality of education, building and rebuilding of faculty competence assumes importance. The focus needs to be in basic and applied sciences relevant to different branches of agriculture sciences. Building faculty competence will ensure skill and entrepreneurship development among graduates for taking up enterprise and be job provider. ICAR needs to develop HRD policy to make mandatory training and retraining of the faculty. For this purpose the Committee recommends providing support for national and international trainings to the extent of Rs.150 crore. Out of this, Rs. 25 crore be earmarked for providing facilities to the faculty members on return for maximizing the impact and benefit from training overseas.

d. *Structured trainings:*

- In-service training on global developments and issues pertaining to management of education
- Training for Comptrollers and Registrars on educational administration and financial management
- Training for Heads of the Departments on educational administration, evaluation systems and management
- Refresher program for teachers on applied and basic courses
- Training for technical, administrative and financial staff

e. *Focused effort of human resource development on following areas:*

- Educational technologies and their applications
- Technology-based teaching learning (ICT and multimedia)
- Experiential learning and group learning
- Personality development
- Communication and presentation skills
- Developing winning research proposals
- Quality assurance in education
- WTA and GATTS
- Content development for distant education
- Evaluation of students' learning
- Andragogy for self-employment and entrepreneurial skills
- Curriculum design and development

The requirement of training needs to be made at college level and training designs be decided as per the needs. The training needs should be based on the analysis of strengths and weaknesses of the department and the requirement may be an individual or a group training. The objectives of these trainings should aim at:

- Acquiring skills in the newly emerging areas and cutting edge technologies.
- Updation of knowledge in frontier areas.

The Committee recommends the following:

- **Induction training:** ICAR has been organizing induction training for scientists at initial entry level and this has been appreciated by all. SAUs are also required to build up facilities for similar induction trainings for a period of atleast 4 months focussing

on computer literacy, knowledge about national and international agriculture, curriculum development, financial and administrative rules and procedures, etc.

- **Training overseas:** In key emerging areas where facilities are not available in India, faculty need to be trained in best of the institutions globally. It is recommended the faculty be sent for training overseas at regular intervals for a period ranging from three months to one year depending upon the area and the time required for necessary skill acquisition. The focus need to be in basic and applied sciences relevant to different branches of agriculture sciences. Building faculty competence will ensure skill and entrepreneurship development among graduates for taking up enterprise and be job provider. ICAR need to develop HRD policy to make mandatory training and retraining of the faculty. For this purpose the Committee recommends providing support for national and international trainings to the extent of Rs.150 crores. Out of this Rs. 25 crores be earmarked for providing facilities to the faculty members on return for maximizing the impact and benefit from training overseas.
- State Agricultural Universities lack one centralized training centre for training faculty on the lines of NAARM for ARS Scientists, Academy in Dehradun for Civil Services and Forest Services, Academic Staff College under University Grants Commission (UGC).National Academy of Agricultural Research Management, Hyderabad has already initiated giving training to newly recruited faculty of SAUs and to senior faculty through its regular and executive / management development programme but it is insufficient for the SAUs. Looking at the training needs of the new and old faculty of SAUs, the V Deans committee felt that one regional training centre for faculty and learning in each zone (East, West, North and south zones of India) may be established with full assistance from ICAR/ DARE.
- An understanding may be made between ICAR and concerned institutions (IIM's, NAARM etc.,) for imparting training to senior executives of the SAUs on human resource development and management, inspiration and motivation of the faculty till the establishment of regional training centre for training and learning are established by ICAR.
- Funding by ICAR to set-up training centres/centers of excellence is expected to be widened further. Each university should identify the potential of the region and create the Centre of Excellence to cater the needs of stakeholders.
- Ongoing winter/Summer Schools, training by CAFT centers are not able to attract desired number of participants. The participants in these training do not represent a national scenario. Therefore, the quality of these trainings needs to be revamped in order to attract participants from across the Country. It was also felt that the trainings should focus more on practical and practice oriented contents.
- *Performance based incentives / awards / rewards / recognition:* Some annual incentives/ awards in form of advance annual increment should be started to the outstanding performers based on the annual assessment report. The timely annual assessment system across the SAUs may be put in place.
- *Students evaluating teachers:* The proforma needs revision. The IARI model for identification of best teacher may be adopted across the universities which includes the inputs from the students of second year M.Sc., and second and third year Ph.Ds. Based on inputs of the students given, 2-3 teachers are identified from each discipline to invite their biodata in a prescribed proforma. These are evaluated and recommended by an external committee based on the criteria given in the proforma such as number of classes taken, participation in credit seminar, students guided, publications from students' thesis, awards won by the students, placement of students guided by the faculty etc.,

- Respective Deans should monitor their teacher's performance. Though the performance indicators are already in place in many SAUs but the following points may be considered for evaluation of faculty by the Deans.
- Punctuality in adhering to schedule of classes, examinations, submission of students' progress/ thesis etc.
- Technologies/ varieties/ patents /products developed and approved by the SAUs/ authorities.
- Research publications in peer reviewed journals (preferably with more than 6 rating but not less than 5)
- Invited participation in Seminar/Symposia/ National Level Committees
- M.Sc. /Ph.D. students guided and publications arising from the students' thesis
- Awards and recognitions from the recognized state /central organizations
- Externally funded projects as PI and Co-PI
- Not many faculty training opportunities have been created till now for FST resulting human resource as the major constraint at almost all the SAUs. Refresher training program should be developed for the discipline of Food Processing and organized periodically. Adequate industrial training and international exposure must be there for all teaching faculty.
- Teaching faculties should also be trained on industrial operations, plant inspections, assessment, licensing, certification and auditing activities, etc. for the benefit of knowledge transfer to the students.

REFORMS IN GOVERNANCE OF SAUs

With an objective to have uniformity in the governance of State Agricultural Universities, ICAR brought out first Model Act in 1966 and has been revising it from time to time. The last revision was made by the Council in 2009. The act has not been adopted by most of the SAUs. The Committee was of the view that there needs to be a body with statutory powers to regulate agricultural education for quality assurance as this will go a long way in ensuring relevance and quality of education in addition to soundness and vibrancy of the national agricultural education system.

The Committee recommends the adoption of following provisions of the Model Act by all the SAUs:

AUTHORITIES OF THE UNIVERSITY

The following shall be the authorities of the University namely:-

(1) Board of Management;
(2) Academic Council;
(3) Research Council;
(4) Extension Council/Extension Education Council;
(5) Faculties and their Board of Studies;
(6) Such other bodies of University as may be declared by the Statutes to be authorities of University;

Board of Management and its Constitution

(1) The Chancellor shall, soon after the first Vice-Chancellor is appointed, constitute the Board of Management.
(2) The Board of Management shall constitute of the following:-
   (i) The Vice-Chancellor –Chairperson
   (ii) Principal Secretary/ Secretary, Department of Agriculture, State Government or his nominee not below the rank of Joint secretary.
   (iii) Principal Secretary/ Secretary, Finance Department of the State Government or his nominee not below the rank of Joint secretary.
   (iv) Principal Secretary/ Secretary from the Department of Animal Husbandry/ Fisheries/ Forestry or his nominee not below the rank of Joint secretary, may be nominated by the State Government keeping in view the teaching and research programmes at the University.
   (v) One eminent educationist (not below the rank of Professor) from the field of Agriculture and allied Sciences to be nominated by the Chancellor.
   (vi) One representative of State Legislative bodies such as Assembly/Council or any other autonomous/ para-statal/ Zila Parishad body, with substantial contribution towards rural upliftment and empowerment, to be nominated by the Chancellor.
   (vii) One outstanding woman social worker having background of rural advancement to be nominated by the Chancellor.
   (viii) One progressive farmer from the jurisdiction of the university to be nominated by the Government.
   (ix) One distinguished agro-industrialist to be nominated by the Government.
   (x) One eminent educationist from outside the university from the field of Agriculture and allied science to be nominated by the Vice-Chancellor.
   (xi) One representative from the Indian Council of Agricultural Research (ICAR) to be nominated by the Director General, ICAR.
   (xii) One Director to be nominated by the Vice-Chancello.r

(xiii) One Dean to be nominated by the Vice-Chancellor.
(xiv) Registrar – Secretary

(3) The term of the office of the Members of the Board other than the ex-officio members shall be two years.

(4) When a vacancy occurs in the office of any member by the reason of death, resignation or any cause other than the expiry of term, the vacancy shall be filled in accordance with the provisions of this section and the person who fills such vacancy shall hold office for the residue of the term for which the person whose place he/she fills would have been a member.

(5) No action or proceedings of the Board shall be invalid merely on the ground of the existence of any vacancy or defect in the constitution of the Board.

(6) One third of the members of the Board shall form quorum at a meeting of the Board. Provided that if a meeting of the Board is adjourned for want of quorum, no quorum shall be necessary at the next meeting called for transacting the same business.

(7) No other officer or employee of the University shall be eligible to be a member of the Board under clause (v) to (x) of sub-section (2) of this section.

(8) The Board for the purpose of consultation may invite any person having experience or special knowledge on any subject under consideration to attend its meeting. Such person may speak or otherwise take part in the proceedings of such meeting but shall not be entitled to vote. Any person so invited shall be entitled to such allowances for attending the meeting as may be prescribed.

(9) Normally the Board shall on dates to be fixed by the Vice- Chancellor meet at least twice a year. However, Vice-Chancellor may whenever, he thinks fit and shall, upon the requisition in writing signed by not less than five members of the Board, convene a special meeting of the Board.

Powers and Functions of the Board

(1) Subject to the provisions of this Act and the Statutes, the Board shall be the Chief Executive Body of the University and shall manage and supervise the properties and activities of the University and shall be responsible for the conduct of all administrative affairs of the University not otherwise provided for in this Act.

(2) Without prejudice to the generality of the foregoing powers, the Board shall exercise and perform the following powers and functions:-

(i) To consider and approve the financial requirements, estimates and the budget of the University.

(ii) To hold and control the property and the funds of the University and issue any general directive on behalf of the University.

(iii) To accept or transfer any property on behalf of the University.

(iv) To administer funds placed at the disposal of the University for the purpose intended.

(v) To arrange for the investment and withdrawal of the funds of the University.

(vi) To borrow money for capital investments with prior approval of the State Government and make suitable arrangements for its repayment.

(vii) To accept on behalf of the University trusts, bequests and donations.

(viii) To consider and approve the recommendations of the Academic, Research and Extension Councils where required.

(ix) To direct the form and use of the common seal of the University.

(x) To appoint such committees and bodies as it may deem necessary and set down the terms of reference thereof in accordance with the provisions of this Act and the Statutes.

(xi) To consider and approve establishment, amalgamation and abolition of Colleges, Department, Centre or Research Station/sub-station on the recommendation of Academic Council, Research Council or Extension Council. New college / faculty shall be established only after approval from the Government.

(xii) To create teaching, research and extension education posts with the approval of the State Government.

(xiii) To approve the recommendations of Selection Committee in the prescribed manner for appointment of officers, teachers and employees of the rank of Assistant Professor and above.

Academic Council

(1) Academic Council shall consist of the following members-

(i) The Vice-Chancellor - Chairperson
(ii) Directors of Research and Extension
(iii) All Deans
(iv) Two Heads of the Department from each faculty nominated by the Vice-Chancellor on rotational basis.
(v) One teacher of the Professor rank from each faculty to be nominated by the Vice Chancellor on rotational basis.
(vi) One eminent agriculture educationist from outside the University to be nominated by the Vice-Chancellor.
(vii) Registrar
(viii) Director of Education – Member Secretary

Comptroller and University Librarian shall be the non-member invitees.

(2) Academic Council may co-opt as members not more than two persons for such period and in such manner as may be prescribed so as to secure adequate representation of different sectors of agriculture and allied fields.

(3) All members of the Academic Council other than the ex-officio members and members referred in sub-section (2) shall hold office for a term of two years.

(4) One third of the members of the Academic Council shall form quorum at a meeting of the Council.

Provided that if a meeting of the Council is adjourned for want of quorum, no quorum shall be necessary at the next meeting for the transaction of the same business.

(5) Normally the Academic Council shall meet once in each semester on such dates as may be fixed by the Vice-Chancellor. However, special meetings of the Academic Council can be called by the Vice-Chancellor.

Powers and Functions of the Academic Council

(1) The Academic Council shall, subject to provisions of this Act and the Statutes, have the power by regulations of prescribing all courses of study and determining curricula, and shall have control on teaching and other educational programmes within University, and shall be responsible for the maintenance of standards thereof.

(2) It shall have power to make regulations consistent with this Act and the Statutes relating to all academic matters subject to its control and to amend or repeal such regulations.

(3) In particular, and without prejudice to the generality of the foregoing power, the Academic Council shall have power:-

(i) To advise the Board and Vice-Chancellor on all academic matters.
(ii) To make recommendations for the institution of Professorships, Associate Professorships, Assistant Professorships and other teaching posts including

posts in research and extension education and in regard to the duties thereof.

(iii) To make recommendations for adjunct professorship.

(iv) To make recommendations for the establishment/amalgamation/abolition of Faculty, College, Department of teaching, research and extension education.

(v) To make regulations regarding the admission of students to the university, and determine the number of students to be admitted.

(vi) To make regulations relating to the courses of study leading to degrees, diplomas and certificates.

(vii) To make regulations relating to the conduct of examinations and to maintain and improve standards of education.

(viii) To make recommendations to the Board regarding conferment of honorary degree.

(ix) To make recommendations regarding the qualifications to be prescribed for teachers in the University.

(x) To exercise such other powers and perform such other functions as may be conferred or imposed on it under the provisions of this Act, by the Board or Vice-Chancellor.

Research Council

(1) There shall be a Research Council consisting of the following members-

(i) The Vice-Chancellor - Chairperson

(ii) The Directors of Agriculture/Horticulture/Animal Husbandry/Fisheries and Chief Conservator of Forests (depending upon research mandate and programmes of the University) of the Government

(iii) Directors of Education and Extension

(iv) All Deans

(v) All Heads of Departments/ Associate Directors

(vi) Research Council may co-opt as members not more than four persons including one progressive farmer for such period and in such manner as may be prescribed so as to secure adequate representation of different sectors of agriculture and allied fields;

(vii) Director of Research - Member Secretary.

Registrar and Comptroller shall be the non-member invitees.

Functions of Research Council

(1) The Research Council shall consider and make recommendations in respect of-

(i) Research programmes and projects undertaken or to be undertaken by the various University scientists in the field of Agriculture and allied Sciences and their prioritization, monitoring and evaluation.

(ii) Physical, fiscal and administrative facilities required for implementing research projects.

(iii) Orienting research to meet farmers and other stake holders needs.

(iv) Public-Private Partnership in research.

(v) Any other matter pertaining to research programmes which may be referred to by the Vice-Chancellor or the Board or any other authority of the University.

Extension Council/ Extension Education Council

(1) There shall be an Extension Council consisting of the following members-

(i) Vice-Chancellor – Chairperson.

(ii) Directors of Agriculture/Horticulture/Animal Husbandry/Fisheries and Chief Conservator of Forests (depending upon mandate and programmes of the University) of the Government.

(iii) Director of Education, Research and all Associate Directors/Joint Directors.

(iv) All Deans.
(v) All Heads of the Departments/Regional Research Station/ Centers.
(vi) Two eminent persons in the field of Extension Education from outside nominated by the Vice-Chancellor.
(vii) Two progressive farmers to be nominated by the Vice-Chancellor.
(viii) Vice Chancellor may co-opt up to two members from related organizations.
(ix) Director of Extension - Member Secretary.

Registrar and Comptroller shall be the non-member invitees.

Functions of the Extension Council/ Extension Education Council

(1) Extension Council shall consider and make recommendations in respect of-
(i) The Extension Education Programmes and Projects of the University.
(ii) Coordination of Extension Education Activities.
(iii) Development of farmers' Education, Training and Advisory Services.
(iv) Monitoring and evaluation of the Extension Education Programmes and Projects of the University.
(v) Any other matter referred to it by the Vice-Chancellor, Board or any other authority of the university.

Faculties and Board of Studies

1. The University shall have the faculties.
2. Each faculty shall have Board of Studies consisting of the following members:
   (i) Dean of Faculty – Chairperson.
   (ii) Deans of the constituent colleges of the faculty.
   (iii) All Heads of the Departments of the concerned faculty.
   (iv) One elder faculty member from each Department nominated by the Dean of Faculty.
   (v) A senior Head of the Department – Member Secretary.
3. The functions of each faculty shall be as follows:
   (i) To review teaching programme and suggest improvement thereof.
   (ii) To consider the recommendations of the Committee of Courses and Curricula or similar body of department/faculty and submit to the Academic Council for approval.
   (iii) To perform such other functions as may be assigned to it by the Academic Council or Vice-chancellor.

Constitution of Committees

Every authority shall have the power to appoint Committees which may unless otherwise provided in this Act or Statutes consist of the members of the authority and such other persons as it may deem fit.

Provisions in relation to Membership of Authorities

(1) Save as otherwise provided in this Act, if any member other than ex-officio member of any authority or body of the University, is unable by reason of his death, resignation, removal or otherwise to complete his full term of office, the vacancy so caused shall as soon as convenient, be filled by the appointment, nomination or co-option, as the case may be and the person so appointed, nominated or co-opted shall fill such vacancy for the un-expired portion of the term for which the member in whose place such person is appointed, nominated or co-opted would otherwise have continued in office.

(2) The Board may remove any person from membership of any authority or body of the University on the ground that such person has been convicted of any offence involving moral turpitude or conduct not befitting the office held by the concerned member with the approval of the Chancellor, except that prior approval of the

Chancellor shall not be necessary where such a person has been convicted by a competent Court of law.

Provided that no such order shall be made against any person without giving reasonable opportunity of being heard.

(3) A person who is a Member of any authority or body of the University as a representative of another body whether of the University or not, shall cease to be a member of such authority or body if before the expiry of the term of his membership he ceases to be a member of that other body by which he was appointed or nominated.

(4) Whenever any person becomes a Member of any authority or body of the University by virtue of the office held by him, he shall forthwith cease to be a member of such authority or body if he/she ceases to hold such office before the expiry of the term of his membership.

Provided that he shall not be deemed to have ceased to hold his office merely by reason of his proceeding on leave for a period not exceeding four months.

(5) Any member, other than an ex-officio member of any authority or body of the University may resign his office by letter addressed to the Vice-Chancellor and such resignation, upon acceptance, shall take effect from the date on which the same is submitted.

21**. Validity and Protection of Acts**

(1) The university shall adhere to the acts and laws of the union and the state.

(2) No act or proceeding of any authority or body of the University shall be invalid by reason of the existence of any vacancy among its members or by reason of some person having taken part in the proceedings who is subsequently found to have been not entitled to do so.

(3) Save as otherwise provided in this Act, all the acts done or orders made in good faith by the University or any of its authorities shall be final and no suit shall be instituted against or damages claimed from the University or its authority for anything done or purported to have been done in pursuance of this Act or the Statutes or the Regulations.

(4) No suit or other legal proceeding shall lie against any officer or other employee of the University in respect of anything which is in good faith done or intended to be done in pursuance of this Act or any Statutes made there under.

Officers of the University

Officers

The following shall be the officers of the University namely-

(i) The Chancellor
(ii) The Vice-Chancellor
(iii) The Directors
(iv) The Deans
(v) The Registrar
(vi) The Comptroller
(vii) The University Librarian
(viii) Such other persons in the service of the University as may be declared by the Statutes to be the Officers of the University.

The Chancellor

(1) The Governor of the respective State of shall by virtue of his office be the Chancellor of the University.

(2) The Chancellor shall be the Head of the University and shall when present, preside at the Convocation of the university.

(3) Every proposal to confer an honorary degree shall be subject to the confirmation of the Chancellor.

(4) The Chancellor may by an order in writing annul any order or proceeding of the officer or authority of the University which is not in conformity with this Act and Statutes;

Provided that before making any such order he shall call upon the officer or authority concerned to show cause why such an order should not be made and if any cause is shown within the time specified in this behalf, he shall consider the same.

(5) The Chancellor shall exercise such powers and perform such other duties as are conferred on him by this Act or the Statutes.

The Vice-Chancellor

(1) The Vice-Chancellor shall be a whole time officer of the University and he shall be appointed by the Chancellor from the panel of eminent educationists in Agricultural Sciences drawn by the Search Committee. The Search Committee shall consist of the following Members:-

(i) Director General, ICAR
(ii) One nominee of the Government
(iii) One nominee of the Chancellor

Provided that one of these Members shall be nominated by the Chancellor to act as Convener.

Nominee of the Government and the Chancellor shall be in the rank of Vice Chancellor or equivalent.

(2) A person who has attained academic excellence and demonstrated leadership qualities in research, education and extension shall be eligible for candidature to the post of Vice Chancellor.

(3) Notice of Search Committee shall be widely publicized and go to all agricultural universities/institutes. The Search Committee will select and suggest a panel of the three names.

(4) The Vice-Chancellor shall hold office for a term of five years or until he attains the age of 70 years, whichever is earlier. The emoluments and other conditions of the service of the Vice-Chancellor shall be such as may be prescribed by UGC/ICAR.

(5) The Vice-Chancellor may relinquish his office by resignation in writing under his hand addressed to the Chancellor which shall be delivered to the Chancellor normally 60 days prior to the date on which the Vice-Chancellor wishes to be relieved from his office, but the Chancellor may relieve him earlier.

(6) In the event of a temporary vacancy of the post of Vice-Chancellor or his absence on leave or for any other reason, senior most Director/Dean of Faculty/Registrar of the University, with the approval of the Chancellor, may perform the duties of the Vice-Chancellor but his period shall not exceed six months.

(7) The Vice-Chancellor shall not be removed from his office except by order of the Chancellor passed on the ground of mis-behaviour or incapacity or if it appears to the Chancellor that the continuance of the Vice-Chancellor in office is detrimental to the interests of the University, after due inquiry by such person who is or has been a Judge of High Court to be nominated by the Chancellor in which the Vice-Chancellor, shall have an opportunity of making his representation.

Powers and Duties of the Vice-Chancellor

(1) The Vice-Chancellor shall be the Principal Executive Officer of the University and ex-officio Chairman of the Board, Academic Council and other authorities and shall

in the absence of the Chancellor, preside at the Convocation of the University and confer degrees on persons entitled to receive them.

(2) The Vice-Chancellor shall exercise overall control over the affairs of the University and shall be responsible for due maintenance of discipline in the university.

(3) The Vice-Chancellor shall convene meetings of the Board of Management, Academic Council, Research Council and Extension Council.

4) The Vice-Chancellor shall ensure faithful observance of the provisions of this Act and Statutes and Regulations.

(5) The Vice-Chancellor shall be responsible for the presentation of the annual financial estimates and the annual accounts to the Board of Management.

(6) The Vice-Chancellor may take any action in any emergency which in his opinion calls for immediate action. He shall in such case and as soon as may be thereafter report his action to the authorities who would ordinarily have dealt with the matter. If the authority disagrees with the action of the Vice-Chancellor the matter shall be referred to the Chancellor whose decision shall be final.

(7) Where any action taken by the Vice-Chancellor under sub- sections (6) affects any person in the service of the University to his disadvantage, such person may prefer an appeal to the Board within thirty days from the date on which such person has been served a notice of the action taken.

(8) If the Vice-Chancellor is satisfied that a decision of the Board is not in the best interest of the University, he shall refer it to the Chancellor whose decision thereon shall be final.

(9) Subject to the provisions of the preceding sub-sections, the Vice Chancellor shall give effect to the decisions of the Board regarding the appointments, promotions and dismissal of officers, teachers and other employees of the University.

(10) The Vice-Chancellor shall be responsible for the proper administration of the affairs of the University and for a close co-ordination and integration of teaching, research and extension.

(11) The Vice-Chancellor shall exercise such other powers and perform such other duties as are conferred or imposed upon him under the provisions of this Act and the Statutes.

Other Officers of the University

General Terms & Conditions: The officers of the University referred to in clause (iii) to (viii) of section 22 shall be appointed by the Vice-Chancellor with the approval of the concerned authority of the University on such terms and conditions as may be prescribed.

Provided that the Vice-Chancellor may make appointments of such officers as a temporary measure for a period of six months under intimation to the concerned authority of the University.

Directors, Deans, Registrar, Comptroller etc.

(1) **Director of Education**

(a) Shall be responsible for planning and academic coordination for teaching, quality of education, policy matters and system regarding resident instruction, overseeing the examination and evaluation, development and enforcement of curricula, development of educational technology and teachers' training programme(s), HRD of faculty, etc.

(b) Shall function as Member Secretary of the Academic Council.

(2) **Director of Research**:

(a) Shall be responsible for the direction and co-ordination of research programmes in the University as laid down in section 29 and efficient working of research stations.

(3) **Director of Extension/ Extension Education:**

(a) Shall be responsible for the Agriculture Extension Education programmes as laid down in Section 30.

(4) **Dean:**

(a) Shall be Head of the College and be responsible for teaching, research and extension activities in the College.

(5) **Dean of Faculty**

(a) Shall be the Chairman of Board of Studies of the concerned faculty and shall be responsible to the Vice Chancellor for the organization and implementation of the teaching programme of the faculty.

(6) **Dean of Students Welfare:**

(a) Shall plan and direct the programme of students' advisement and counseling and to enlist the co-operation of prospective employers and employment agencies to assist in the placement of graduates of the University and to promote discipline amongst the students of the University.

(b) Shall plan and organize students' extra-curricular activities such as sports, cultural and other recreational activities, National Cadet Corps, NSS and communication skill improvement and other allied activities.

(c) Shall make arrangements and supervise management of students' hostel, cafeteria and mess.

(d) Shall supervise and control medical and health services and other welfare measures in the University.

(7) Registrar

(a) Shall be Ex-officio Secretary of the Board of Management and permanent invitee of all councils.

(b) Shall be responsible for the due custody of records and common seal of the university.

(c) Shall be responsible for establishment matters and general administration in the university as prescribed.

(d) Shall be responsible for admissions of UG and PG and conduct and management of examinations at UG and PG, maintenance of permanent records of the students at the university including the courses taken, credits obtained, degrees, prizes or other distinctions and other items pertaining to academic performance and discipline of the students.

(8) **Comptroller**

(a) Shall be responsible for preparation of the budget, the statement of accounts, management of the funds and investments of the University.

(b) Shall be responsible for ensuring that expenditure is made as authorized.

(c) Shall arrange periodical internal inspection of the accounts maintained in various units of University.

(d) Shall be responsible for the maintenance of the accounts of the University in the form and manner as approved by the Board and keep constant watch on the state of cash and bank balance and on the state of investment.

(e) Shall see that the asset registers are maintained up-to date and that the regular stock checking is conducted.

(9) University Librarian:

He shall be responsible for the maintenance and management of the University Library Information System and to guide and co-ordinate library activities of all the constituent units of the University.

Subject to the provisions of this Act, the Officers of the University referred to in clauses (iii) to (viii) of section 22 shall perform such other duties as may be prescribed or as may be assigned to them from time to time, by the Vice-Chancellor.

EDUCATION, RESEARCH AND EXTENSION

Education

(1) Subject to provisions of this Act, Education in the University shall include Bachelor's, Master's and Doctoral degree programmes and short-term diploma / certificate courses in the disciplines of Agriculture and allied sciences as prescribed.

(2) The Educational programmes would maintain congruence with the State and National policies.

(3) The University shall put in place initiatives for e-learning, distributed / distance education, ICT-enabled knowledge sharing etc.

(4) Programmes of Agricultural Education should aim at producing competent and skilled graduates and post-graduates.

Research

(1) Subject to the provisions of this Act and the Statutes, the University shall carry on strategic, basic and applied research in agriculture.

(2) The University through its research organization shall be the principal agency of control over research activities in Agriculture, Animal Husbandry and other allied branches in its jurisdiction.

(3) The University with the concurrence of Government may establish Regional/Zonal Research Stations and Sub-Stations in different agro-climatic zones in its territorial jurisdiction for the conduct of research including operational research.

Extension

(1) Extension Education programmes shall be established in the University and shall, subject to the provisions of this Act and the Statutes, ensure technology assessment and refinement and facilitate adoption of technology based on research findings to farmers and others for accelerated agricultural growth. It shall conduct demonstrations and training programmes for the benefit of various stakeholders. Extension Education programmes shall be coordinated with various units of the University and other appropriate agencies of the Centre and the State.

(2) The University shall be responsible for developing models of Agricu1tural Extension in the State.

Integration of teaching, research and extension

(1) In consultation with the appropriate officers of the University, the Vice-Chancellor shall be responsible for taking such steps as may be necessary for the full integration of teaching, research and extension activities of the University.

(2) Every faculty member borne on teaching cadre shall devote some time (not exceeding 30% and as decided by the Vice Chancellor in consultation with the appropriate officers of the University) in an academic year for undertaking research and/or extension besides teaching. Likewise a faculty member borne on research or extension shall spend some time in teaching.

(3) All teaching, research and extension staff located in the college shall be under the administrative control of Dean of the College and overall technical control of Director (Research) and Director (Extension) as the case may be.

(4) The University shall develop its programme of research and extension keeping in view the regional needs of the State and provide the appropriate technological backstopping, to the Government and other stakeholders.

FUNDS AND ACCOUNTS

The University Funds

(1) The University shall have a General Fund to which shall be credited:-
   (i) Its income from fees, endowments and grants and income from properties of the University including hostel, experimental stations and farms.
   (ii) Contribution and grants made by the Government on such conditions as are consistent with the provision of this Act.
   (iii) Other contributions, grants, donations, beneficiations and loans and other receipts.

(2) The University shall form a fund called the Foundation Fund from contributions and grants made by the Central Government or the State Government or approved agency for being credited to that fund and such other sums as may be specified by the Board, shall be credited to this fund. The Board may as and when necessary retransfer such amount as may be specified, from the Foundation Fund to the General Fund, in manner prescribed.

(3) The University shall furnish statements of accounts, reports and other particulars to the Government relating to any grant made by the Government and shall take such action and furnish such statements, accounts, reports and other particulars relating to the utilization of any grant within such time and manner as the Government may direct.

(4) It shall be competent for the University in furtherance of its objectives to accept the grants from the Government or any other State Government or the Central Government or Statutory Bodies or endowments or donations under such conditions as may be agreed upon between the University and the granter or donor.

Management of Funds

The General Fund, Foundation Fund and other funds of the University shall be managed according to the provisions laid down by the Statutes.

Accounts and Audit

The Annual Statement of accounts (based on the double entry system of accounting) of the University shall be prepared by the Comptroller and certified by an authority to be nominated or authorized by the Board. The Statement shall include all the money accruing to or received by the University from whatever source and all amount disbursed and paid by the University. Such statement shall be submitted to the Government by the Board normally within six months after close of the financial year to which these pertain.

Provident Fund, Pension and Insurance

(1) The University shall constitute for the benefit of its officers, teachers, ministerial staff and other employees, in such manner and subject to such conditions as may be prescribed, such pension, gratuity, insurance, provident fund, contributory pension fund as it may deem fit.

(2) For such pension, gratuity, insurance and provident fund so constituted by the University, the Government should declare that the provisions of the Provident Funds Act shall apply to such funds as it were Government provident Fund.
   Provided that the University shall have power in consultation with the Finance Committee and the Board to invest Provident Fund amount in such manner as it may determine.

Government Grants

The Government shall every year make the following lump sum grants to the University, namely:-

(i) A grant not less than the estimated expenditure of pay and allowances of the staff contingencies, supplies and services of the University for proper functioning of University.

(ii) A grant to meet the actual pensionary and all other retirement liabilities of the pensioners of the University.

(iii) The State Government shall also make non-lapsable lump sum grant to the University in respect to schemes included in the Five Year Plans and transferred to it for implementation by the University of an amount equal to the net outlay in the annual plan.

Finance Committee

(1) The Board shall constitute a Finance Committee consisting of:-

(i) The Vice-Chancellor – Chairperson.

(ii) Principal Secretary/ Secretary (Finance) to the State Government or his nominee not below the rank of Joint Secretary.

(iii) Principal Secretary / Secretary (Agriculture) to the Government.

(iv) One Director/Dean from amongst the Board Members to be nominated by the Vice-Chancellor.

(v) One nominee of the Board.

(vi) Comptroller - Member Secretary.

Registrar shall be the non-member invitee

(2) Finance Committee shall have the following functions:-

(i) To examine the annual accounts and budget estimates of the University and to advise the Board thereon.

(ii) To review the financial position of the University from to time.

(iii) To make recommendations to the Board on all matters relating to the finances of the University.

STATUTES AND REGULATIONS

Statutes

Subject to the provisions of this Act, the Statutes of the University may provide for any matter connected with the affairs of the University and shall, in particular, provide for the following, namely:

(1) Cnstitution, powers and duties of the Authorities.

(2)Creation, composition and functions of the other Bodies or Committees necessary or desirable for improving the academic life of the University.

(3)Designations, powers, functions, duties, manner of appointment and selections, and terms and conditions of service of the officers other than Chancellor and Vice-Chancellor.

(4) Classification, qualification and manner of appointment, terms and conditions of services and duties of teachers and non-teaching staff of the University.

(5) Terms and conditions of service of the Vice-Chancellor.

(6)Establishment, amalgamation, sub-division or abolition of faculties, Departments/Research Stations/Centres or other units of the University.

(7) Establishment of pension and insurance schemes for the benefit of officers, teachers and other employees of the University and rules, terms and conditions of such schemes.

(8)Holding of Convocation to confer degrees and diplomas.

(9)Conferment and withdrawal of honorary degrees and academic distinctions.

(10) Conditions of service, remunerations and allowances including traveling and daily allowances to be paid to officers, teachers and other persons employed under the University.

(11) Conditions and mode of appointment and the duties of examining bodies and examiners.
(12)Management of Colleges/Centres/Divisions/Departments/Regional Stations/other KVKs/ institutions founded or maintained by the University.
(13) Constitution of Selection Committee for appointment of teachers and other staff.
(14) All other matters which by this Act are to be provided by the Statutes.

Statues how made

(1) Statutes under this Act shall be proposed by the Board and submitted to the Chancellor for his assent and shall be valid only after the assent is received and notified by the Vice-Chancellor.
(2) Any Statute may be amended or repealed by the Board with the assent of the Chancellor.
(3) All Statutes made under this Act shall be published in the official gazette.

Regulations

(1) The authorities of the University may make regulations consistent with this Act and the statutes for:-
  (i) Laying down the procedure for their meetings and number of members required to form the quorum.
  (ii) Providing for matters which by this Act and the Statutes are to be regulated by Regulations.
  (iii) Providing for any other matter solely concerning the authority and not provided for by this Act and the Statutes.
(2) The Academic Council may subject to the provisions of Act and the Statutes, make regulations providing for courses of studies, system of examination, academic calendar, award of degrees and diplomas of the University and other matters related to Resident Instruction.
(3) The regulations made by any authority of the University shall be subject to such directions as the Board may from time to time give in this behalf.
(4) Academic Council of the University may make regulations for-
  (i) The holding of Convocations to confer degrees and diplomas.
  (ii) The conferment of honorary degrees, academic distinctions and withdrawal of degrees.
  (iii) The establishment and abolition of hostels maintained by the University.
  (iv) The institution of fellowships, scholarships, stipends, bursaries, medals and prizes and the conditions of award thereof.
  (v) The entrance or admission of the students to the University and their enrollment and continuance as such and the conditions and procedures for dropping students from enrollment.
  (vi) The fees which may be charged by the University.
  (vii) The course of study to be laid down for all degrees, diplomas and certificates of the University.
  (viii) The conditions under which students shall be admitted to the degrees, diplomas, or other courses and examinations of the University and their eligibility for the award of degrees and diplomas.
  (ix) The conditions for conferment of degrees and other academic distinctions.
  (x) The maintenance of discipline among the students of the University.
  (xi) The special arrangements, if any, which may be made for residence, discipline and teaching of women students and the provision of special courses of study for women.

(xii) The conditions of residence of students of the University and the levy of fees for residence in hostels.

Miscellaneous

Residence of students

The students shall reside in the accommodation maintained by the university or approved by the Vice-Chancellor subject to the conditions as may be prescribed. However, the Vice-Chancellor or an authorized officer of the University may permit the student(s) to reside with their parents or in private accommodations when no such accommodation is available with the University.

Annual Report

The annual report of the University shall be prepared by the Registrar or any other officer, assigned under the direction of the Vice-Chancellor normally within six months from the close of the Financial Year and circulated to the Members of the Board before the meeting at which it is to be considered. The Board shall after consideration of the annual report forward a copy thereof to the Government.

Delegation of powers

The Vice-Chancellor may, by statutes, delegate the powers exercisable under this Act or the Statutes made there under, to any authority, officer, heads of colleges/divisions/departments/ institutions or units/office subject to such conditions and restrictions as the Vice-Chancellor may deem proper.

Constitution of *ad-hoc* committees

Notwithstanding anything in this Act and until such time as the authorities are duly constituted, the Vice-Chancellor may subject to the approval of the Board, after it has been constituted appoint committees temporarily to exercise, perform and discharge any of the powers, functions and duties of such authority under this Act.

Disputes as to constitution of Authorities or Bodies

If any question arises as to whether any person has been duly appointed or is entitled to be a member of any authority or other body of University, the matter shall be referred to the Chancellor whose decision thereon shall be final.

Provided that before taking any such decision, the Chancellor shall give the person affected thereby reasonable opportunity of being heard.

Legal Proceeding

All suits and other legal proceedings by or against the University shall be instituted, prosecuted or defended on behalf of the University by the Registrar or any other officer specifically nominated in this behalf by the Vice-Chancellor.

Appointment to posts in connection with the affairs of University

(1) Subject to the provisions of this Act and the Statutes made there under, appointment to posts and services in connection with the affairs of the University may be made by the Vice-Chancellor with the approval of the concerned authority as prescribed.
Provided that such approval of Board shall not be necessary in respect of appointment of posts carrying scales of pay lower than the pay scale of an Assistant Professor.

(2) Notwithstanding anything contained in this Act and until such time as the Statutes are made or the authorities of the University are constituted, appointments to posts and services in connection with the affairs of the University may be made by the Vice-Chancellor on such terms and conditions as may be approved by the Chancellor.

State Coordination Committee/Council for Higher Agricultural Education and Research (For the States with more than one Agricultural University)

(1) There shall be State Coordination Committee/Council in the State with more than one Agricultural University for purpose of effective co-ordination in the activities of all Agricultural Universities in the State. The composition of coordination committee shall be as under:
   (a) The Chancellor – Chairman.
   (b) Agriculture Minister – Vice Chairman.
   (c) The Committee/Council shall consist of the following other members-
      (i) The Vice-Chancellors of the Agricultural Universities in the State.
      (ii)The Principal Secretary/Secretary of Agriculture, Animal Husbandry, Horticulture, and Fisheries, Finance and Planning to Government as ex-officio members.
      (iii) DDG (Education) or his nominee from ICAR.
      (iv) Principal Secretary / Secretary to the Governor of the State – Convener.

(2) Functions of the State Coordination Committee/Council:
   The Committee would act as a Coordinating body between agricultural universities in the State towards:
   (i) Harmonization of Academic programmes and regulations.
   (ii) Ensuring complementarity and synergy among Agricultural Universities in the State through planning and advisories in education, research and extension.
   (iii) Suggesting new initiatives and action plans for joint endeavors of the State Agricultural Universities and development departments for accelerating agricultural growth.
   (iv) Addressing the generic and inter-university issues/concerns.
   (v) Ensuring autonomy of the Universities in the State.

(3) The Committee shall meet at least twice in a year.

Transitional Provisions

(1) Notwithstanding anything contained in this Act or in the other universities Act in the State or in the Statutes or regulations made under any of these enactments any student who immediately before the commencement of this Act was studying in a college which has been or may hereafter be admitted to the privileges of the University for degree, diploma or certificate of the (other) Universities, in accordance with the regulations of the University be permitted:-
   (a) to complete his course in accordance with the curriculum of studies of (other university in state) University.
   (b) to be examined by the University and if on the results of such examination he qualifies, be entitled to be conferred a corresponding degree or diploma or certificate of the University.
   (c) to appear at the examination within two years of the normal period required for completing the said course of studies.

(2) In the year of the establishment of the University, University examinations of all courses in different faculties and disciplines shall be conducted by other universities in the State as the case may be, and in subsequent years, the examination shall be conducted by the University.

(3) Notwithstanding anything contained in (other Universities in the state) Universities Act, or in Statutes or Regulations made there under, College of Agriculture/Veterinary and other colleges in allied fields (as approved by Government) shall after the commencement of this Act, be dis-affiliated from other University in the state and shall be maintained by the University as constituent College.

(4) All employees of the College, Research Institutes and other offices and institutions of Government Departments whose services along with the Unit have been transferred to the University shall be deemed to be transferred employees of the Government. Such transferred employees shall be governed in accordance with the terms and conditions as determined by the Board in consultation with the Government while those who have been employed by the University shall be subject to the provisions of this Act and the Statutes made there under. The transferred Government employees may opt for the University service on such terms and conditions as may be prescribed through statutes.

Removal of difficulties

(1) If any difficulty arises in giving effect to the provisions of this Act, the Government may, by order do anything which appears to it necessary for the purpose of removing the difficulty.

(2) No order made under sub-section (1) shall be questioned in any Court of law on the ground that no difficulty, as is referred to in the said sub-section, existed to be removed.

(3) Every order published, under this section shall as soon as may be after its publication laid before both Houses of the State Legislature.

B.Tech. (Agril.Engg.)Courses as per Vth Dean(Syllabus effective from Academic Year 2017-18)

No.	Course No.	Title of the Course	Credit Hour	Remarks
		Semester I		
1.	**Math(E)-1.1.1**	Engineering Mathematics-I	3(2+1)	
2.	**Phy(E)-1.1.2**	Engineering Physics	3(2+1)	
3.	**Chem(E)-1.1.3**	Engineering Chemistry	3(2+1)	
4.	**Ag(E)-1.1.4**	Principles of Soil Science	3(2+1)	
5.	**CE-1.1.5**	Surveying and Levelling	3(1+2)	
6.	**CE-1.1.6**	Engineering Mechanics	3(2+1)	
7.	**ME-1.1.7**	Engineering Drawing	2(0+2)	
8.	**ME-1.1.8**	Heat and Mass Transfer	2(2+0)	
9.	**Phy. Edu.-1.1.9**	NSS/NCC/Physical Education	0(0+1*)	
		Total	**22(13+9)**	
		Semester II		
1.	**Math(E)-1.2.1**	Engineering Mathematics-II	3(2+1)	
2.	**AS(E)-1.2.2**	Environmental Science and Disaster Management	3(2+1)	
3.	**AS(E)-1.2.3**	Entrepreneurship Development and Business Management	3(2+1)	
4.	**CE-1.2.4**	Fluid Mechanics and Open Channel Hydraulics	3(2+1)	
5.	**CE-1.2.5**	Strength of Materials	2(1+1)	
6.	**ME-1.2.6**	Workshop Technology and Practices	3(1+2)	
7.	**ME-1.2.7**	Theory of Machines	2(2+0)	
8.	**CSE-1.2.8**	Web Designing and Internet Applications	2(1+1)	
9.	**Phy. Edu.-1.2.9**	NSS/NCC/Physical Education	0(0+1*)	
		Total	**21(13+8)**	
		Semester III		
No.	**Course No.**	**Title of the Course**	**Credit Hour**	**Remarks**
1.	**Ag(E)-2.3.1**	Principles of Horticultural Crops and Plant Protection	2(1+1)	
2.	**Ag(E)-2.3.2**	Principles of Agronomy	3(2+1)	
3.	**AS(E)-2.3.3**	Communication Skills and Personality Development	2(1+1)	
4.	**Math(E)-2.3.4**	Engineering Mathematics-III	3(2+1)	
5.	**CE-2.3.5**	Soil Mechanics	2(1+1)	
6.	**CE-2.3.6**	Design of Structures	2(1+1)	
7.	**ME-2.3.7**	Machine Design	2(2+0)	
8.	**ME-2.3.8**	Thermodynamics, Refrigeration and Air Conditioning	3(2+1)	
9.	**EE-2.3.9**	Electrical Machines and Power Utilization	3(2+1)	

10.	**Phy. Edu. – 2.3.10**	NSS/NCC/Physical Education	0(0+1*)	
		Total	**22(14+8)**	
		Semester IV		
1.	**CE-2.4.1**	Building Construction and Cost Estimation	2(2+0)	
2.	**ME-2.4.2**	Auto CAD Applications	2(0+2)	
3.	**EE-2.4.3**	Applied Electronics and Instrumentation	3(2+1)	
4.	**FMPE-2.4.4**	Tractor and Automotive Engines	3(2+1)	
5.	**PFE-2.4.5**	Engineering Properties of Agricultural Produce	2(1+1)	
6.	**SWCE-2.4.6**	Watershed Hydrology	2(1+1)	
7.	**IDE-2.4.7**	Irrigation Engineering	3(2+1)	
8.	**IDE-2.4.8**	Sprinkler and Micro Irrigation Systems	2(1+1)	
9.	**REE-2.4.9**	Fundamentals of Renewable Energy Sources	3(2+1)	
10	**Phy.Edu.-2.4.10**	NSS/NCC/Physical Education	0(0+1*)	
		Total	**22(13+9)**	
		V Semester		
1.	**FMPE-3.5.1**	Farm Machinery and Equipment-I	3(2+1)	
2.	**FMPE-3.5.2**	Tractor Systems and Controls	3(2+1)	
3.	**PFE-3.5.3**	Agricultural Structures and Environmental Control	3(2+1)	
4.	**PFE-3.5.4**	Post Harvest Engineering of Cereals, Pulses and Oil Seeds	3(2+1)	
5.	**SWCE-3.5.5**	Soil and Water Conservation Engineering	3(2+1)	
6.	**SWCE-3.5.6**	Watershed Planning and Management	2(1+1)	
7.	**IDE-3.5.7**	Drainage Engineering	2(1+1)	
8.	**REE-3.5.8**	Renewable Power Sources	3(2+1)	
9.	**CAE-3.5.9**	Skill Development Training-I (Student READY) Registration only	5(0+5)	
		Total	**27(14+13)**	
		VI Semester		
No.	**Course No.**	**Title of the Course**	**Credit Hour**	**Remarks**
1.	**CSE-3.6.1**	Computer Programming and Data Structures	3(1+2)	
2.	**FMPE-3.6.2**	Farm Machinery and Equipment-II	3(2+1)	
3.	**PFE-3.6.3**	Post Harvest Engineering of Horticultural Crops	2(1+1)	
4.	**SWCE-3.6.4**	Water Harvesting and Soil Conservation Structures	3(2+1)	
5.	**IDE-3.6.5**	Groundwater, Wells and Pumps	3(2+1)	
6.	**FMPE-3.6.6**	Tractor and Farm Machinery Operation and Maintenance	2(0+2)	
7.	**PFE-3.6.7**	Dairy and Food Engineering	3(2+1)	
8.	**REE-3.6.8**	Bio-energy Systems: Design and Applications	3(2+1)	

		Total	**22(12+10)**	
VII Semester				
VII Semester Student READY (Rural and Entrepreneurship Awareness Development Yojana)				
1.	**CAE-4.7.1**	10- weeks Industrial Attachment /Internship (Student READY)	10(0+10)	
2.	**CAE-4.7.2**	10- weeks Experiential Learning On campus (Student READY)	10(0+10)	
3.	**CAE-4.7.3**	Skill Development Training-II (Student READY) Registration only	5(0+5)	
4.	**CAE-4.7.4**	Educational Tour (Registration only)	2 (0+2)	
		Total	**27(0+27)**	
VIII Semester				
VIII Semester Student READY (Rural and Entrepreneurship Awareness Development Yojana)				
1.		Elective course	3(2+1)	
2.		Elective course	3(2+1)	
3.		Elective course	3(2+1)	
4.	**CAE-4.8.4**	Project Planning and Report Writing (Student READY)	10(0+10)	
		Total	**19(6+13)**	
		Grand Total I to VIII semesters	**182(85+97)**	
Elective Courses (Any 3 courses) 9 (6+3)				
1	**SWCE-4.8.1**	Floods and Control Measures	3(2+1)	
2	**SWCE-4.8.2**	Wasteland Development	3(2+1)	
3	**SWCE-4.8.3**	Information Technology for Land and Water Management	3(2+1)	
4	**SWCE-4.8.4**	Remote Sensing and GIS Applications	3(2+1)	
5	**IDE-4.8.5**	Management of Canal Irrigation System	3(2+1)	
6	**IDE-4.8.6**	Minor Irrigation and Command Area Development	3(2+1)	
No.	**Course No.**	**Title of the Course**	**Credit Hour**	**Remarks**
7	**IDE-4.8.7**	Precision Farming Techniques for Protected Cultivation	3(2+1)	
8	**IDE-4.8.8**	Water Quality and Management Measures	3(2+1)	
9	**IDE-4.8.9**	Landscape Irrigation Design and Management	3(2+1)	
10	**REE-4.8.10**	Plastic Applications in Agriculture	3(2+1)	
11	**FMPE-4.8.11**	Mechanics of Tillage and Traction	3(2+1)	
12	**FMPE-4.8.12**	Farm Machinery Design and Production	3(2+1)	
13	**FMPE-4.8.13**	Human Engineering and Safety	3(2+1)	
14	**FMPE-4.8.14**	Tractor Design and Testing	3(2+1)	
15	**FMPE-4.8.15**	Hydraulic Drives and Controls	3(2+1)	
16	**FMPE-4.8.16**	Precision Agriculture and System Management	3(2+1)	
17	**PFE-4.8.17**	Food Quality and Control	3(2+1)	

18	**PFE-4.8.18**	Food Plant Design and Management	3(2+1)	
19	**PFE-4.8.19**	Food Packaging Technology	3(2+1)	
20	**PFE-4.8.20**	Development of Processed Products	3(2+1)	
21	**PFE-4.8.21**	Process Equipment Design	3(2+1)	
22	**REE-4.8.22**	Photovoltaic Technology and Systems	3(2+1)	
23	**REE-4.8.23**	Waste and By-products Utilization	3(2+1)	
24	**CSE-4.8.24**	Artificial Intelligence	3(3+0)	
25	**ME-4.8.25**	Mechatronics	3(2+1)	
26	**REE-4.8.26**	Energy Conservation and Audit in Agricultural Industry	3(2+1)	
			143 (87+56)	

SEMESTER - I

Sr. No.	CourseName	CourseNo.	Credit	L	P	T
1	EngineeringMathematics-1	Math(E)-1.1.1	3(2 +1)	2	1	0

Coursecontent:

Theory:

Matrices:Elementarytransformations,rankofamatrix,reductiontonormalform,Gauss-Jordonmethod to find inverse of a matrix, Eigen values and Eigen vectors, Cayley-Hamilton theorem, linear transformation, orthogonal transformations, diagonalisation of matrices, quadratic forms. PAQ form, Echelonform,Solutionoflinearequations,natureofrank,usingCayley-Hamiltontheoremtofindinverse ofA.Differentialcalculus:Taylor'sandMaclaurin'sexpansions;indeterminateform;curvature,function oftwoormoreindependentvariables,partialdifferentiation,homogeneousfunctionsandEuler'stheorem, compositefunctions,totalderivatives,maximaandminima.Integralcalculus:volumesandsurfacesof revolutionofcurves;doubleandtripleintegrals,changeoforderofintegration,applicationofdoubleand tripleintegralstofindareaandvolume.Vectorcalculus:Differentiationofvectors,scalarandvectorpoint functions,vectordifferentialoperatorDel,Gradientofascalarpointfunction,DivergenceandCurlofa vectorpointfunctionandtheirphysicalinterpretations,identitiesinvolvingDel,secondorderdifferential operator;line, surfaceand volume integrals, Stoke's,divergence and Green's theorems (withoutproofs).

Tutorial:

Tutorials onrankofa matrix, reduction to normal form, consistencyand solution of linearequations, eigen values and eigen vectors, Cayley-Hamilton theorem, diagonalization of matrices, quadratic forms; Taylor'sandMaclaurin'sexpansion, indeterminate form,curvature,tracing ofcurves, partial differentiation,maximaandminima,volumeandsurfaceof revolution,multiple integrals,BetaandGama functions,differentiationofvectors,gradient,divergenceandcurlofavectorpointfunction,line,surface and volume integrals, Stoke's divergence andGreen'sTheorems

Planningof lectures

S. No.	Topicsto becoveredin Lecture	Proposed No. of Lectures
1	Elementarytransformations, rankofa matrix,reduction to normal form, Solution oflinearequations	3
2	Gauss-Jordon methodto find inverse ofa matrix	1
3	Eigen valuesand Eigen vectors, Cayley-Hamiltontheorem, usingCayley-Hamilton theoremto find inverseof A, natureofrank	3
4	Lineartransformation, orthogonaltransformations,diagonalisation ofmatrices, quadraticforms. PAQform, Echelon form	3
5	Taylor'sandMaclaurin's expansions,indeterminateform;curvature	4
6	Partialdifferentiation, homogeneous functions and Euler's theorem, composite functions,totalderivatives,maxima and minima.	4
7	Volumesand surfacesofrevolutionofcurves	2
8	Doubleand tripleintegrals,change oforderof integration, application ofdouble and tripleintegrals to find areaand volume	4
9	vectordifferentialoperatorDel, Gradientofascalarpointfunction,Divergence and Curlofa vectorpointfunction and theirphysical interpretations	4
10	IdentitiesinvolvingDel, second orderdifferentialoperator;line, surfaceand volume integrals	3
11	Stoke's divergence and Green'sTheorems	1
	Total	**32**

Tutorials

S.No.	Topic	No. of Tutorials
1	Rankofa matrix,reductionto normal form, consistencyand solution oflinear equations	2
2	Eigen valuesand eigen vectors, Cayley-Hamilton theorem	2

3	Diagonalization ofmatrices, quadraticforms	2
4	Taylor'sandMaclaurin's expansion,indeterminateform	2
5	Curvature, tracingofcurves	1
6	Partialdifferentiation, maxima andminima	2
7	Volume and surfaceof revolution, multiple integrals, Betaand Gama functions	2
8	Differentiationofvectors, gradient,divergence andcurlofa vectorpoint function	2
9	Stoke's divergence and Green'sTheorems	1
	Total	16

Suggested Readings

Narayan Shanti.2004. DifferentialCalculus. S. Chandand Co. Ltd. New Delhi.
Narayan Shanti.2004. IntegralCalculus. S. Chand andCo. Ltd. New Delhi.
GrewalBS.2004. HigherEngineeringMathematics.Khanna Publishers Delhi.
Narayan Shanti.2004. ATextBookofVector. S. Chand and Co. Ltd. New Delhi.

Sr. No.	CourseName	CourseNo.	Credit	L	P	T
2	**EngineeringPhysics**	**Phy(E)-1.1.2**	**3(2 +1)**	**2**	**1**	**0**

Coursecontent:

Theory:

Dia, Paraand ferromagnetism-classification. Langevin theoryof dia and paramagnetism. Adiabatic demagnetization. Weissmolecularfieldtheory and ferromagnetism.Curie-Weiss law.Waveparticle quality,de-Broglieconcept,uncertainty principle.Wavefunction.Timedependentandtimeindependent Schrodingerwaveequation,Qualitativeexplanationof Zeemaneffect,StarkeffectandPaschanBack effect, Ramanspectroscopy.StatementofBloch's function.Bandsiiisolids,velocity ofBloch'selectron andeffectivemass.Distinctionbetweenmetals. insulators andsemiconductors.Intrinsicandextrinsic semiconductors,lawofmassaction.Determinationofenergy gapinsemiconductors.Donorsandacceptor levels.Superconductivity,criticalmagneticfield. Meissnereffect.Isotopeeffect. Type-IandII superconductors, Josephson'seffectDCandAC,Squids.Introductiontohigh $T_c$superconductors. SpontaneousandstimulatedemissionEinsteinAandBcoefficients.Populationinversion,He-Neand Ruby lasers.Ammoniaand Rubymasers,Holography-Note.Opticalfiber.Physicalstructure.basictheory. Mode type, input output characteristics of optical fiber and applications. Illumination: laws ofillumination,luminous flux, luminousintensity, candlepower, brightness.

Practical:

TofindthefrequencyofA.C.supplyusinganelectricalvibrator;Tofindthelowresistanceusing Carey Fosterbridgewithoutcalibrating thebridgewire;To determinedielectric constantofmaterialusing De Sauty'sbridge;Todeterminethevalueofspecificcharge(e/m)forelectronsby helicalmethod;Tostudy theinducede.m.f.asafunctionofvelocityofthemagnet;Toobtainhysteresis curve(B-Hcurve)ona C.R.O. and to determine related magnetic quantities;To studythe variation ofmagnetic field with distance along theaxisofacurrentcarrying circularcoilandtodetuning theradiusofthecoil;Todeterminethe energyband gap in a semiconductor usinga p-n Junction diode;To determine the slit width from Fraunhoferdiffractionpatternusing laserbeam;Tofindthenumericalapertureofopticalfiber:Tosetup thefiberopticanalog anddigitallink;Tostudy the phaserelationshipsinL.R.circuit;Tostudy LCR circuit;To study thevariationsof thermoemfofacopper-constantan thermo-couplewithtemperature;To findthe wave length oflightbyprism.

Planningof lectures

S. No.	Topicsto becoveredin Lecture	Proposed No. of Lectures
1	Dia, Para and ferromagnetism-classification. Langevintheoryofdia and paramagnetism	2
2	Adiabatic demagnetization.Weissmolecularfield theoryand ferromagnetism	2
3	Curie-Weiss law. Wave particle quality, de-Broglie concept	2
4	Uncertaintyprinciple. Wave function.Time dependentSchrodingerwave equation	3
5	Time independentSchrodingerwave equation	2
6	Qualitative explanation ofZeeman effect, Starkeffect	3
7	Paschan Backeffect, Raman spectroscopy.	2
8	StatementofBloch'sfunction. Bandsiiisolids, velocityofBloch's electron and effectivemass.	2
9	Distinction between metals.insulatorsandsemiconductors.	2
10	Intrinsicandextrinsic semiconductors, law of mass action.	1
11	Determination ofenergy gap in semiconductors. Donors and acceptorlevels.	1
12	Superconductivity, criticalmagneticfield.Meissnereffect	1
13	Isotope effect. Type-I and II superconductors	1
14	Josephson's effect DC and AC, Squids.	1
15	Introduction to high Tc superconductors.	1
16	Spontaneous and stimulated emission, Einstein A and B coefficients.	1

17	Population inversion, He-Ne and Ruby lasers	1
18	Ammonia and Ruby masers, Holography-Note.	1
19	Optical fiber. Physical structure. basic theory.	1
20	Mode type, input output characteristics of optical fiber and applications.	1
	Illumination: laws of illumination, luminous flux, luminous intensity, candle	
	Total	**32**

Practicals

S.No.	Topic	No. of Praticals
1	Tofind the frequencyofA.C. supplyusingan electricalvibrator	1
2	TofindthelowresistanceusingCareyFosterbridgewithoutcalibratingthebridge wire	1
3	To determine dielectric constantofmaterialusingDe Sauty's bridge	1
4	To determine the valueofspecific charge (e/m) forelectrons byhelicalmethod	1
5	Tostudythe induced e.m.f. asafunction ofvelocityofthe magnet;	1
6	To obtainhysteresis curve (B-Hcurve)on a C.R.O. and to determine related magnetic quantities	1
7	Tostudythe variation ofmagneticfield with distancealongtheaxis ofa current carryingcircularcoilandtodetuningtheradiusofthe coil	1
8	To determine the energyband gap in asemiconductorusinga p-n Junction diode	1
9	To determine the slitwidthfromFraunhoferdiffractionpattern usinglaserbeam	1
	Determination ofultrasonicwave velocityina liquid medium	1
10	Tofind the numericalaperture ofopticalfiber	1
11	Tosetup the fiberoptic analogand digitallink	1
12	Tostudythe phaserelationships in L.R.circuit	1
13	TostudyLCRcircuit	1
14	Tostudythe variations ofthermo emfofa copper-constantanthermo-couple with temperature	1
15	Tofind the wave lengthoflightbyprism	1
16	Tostudythe phaserelationships in L.R.circuit	1
	Total	**16**

Suggested Readings

BrijlalandSubrahmanyam. TextBookofoptics.S. Chand and Co.,New Delhi.
SarkarSubirKumar. OpticalState Physics and FiberOptics. S. Chand and Co.,New Delhi.
Gupta S L,KumarVSharma R C. Elements ofSpectroscopy. PragatiPrakasam, Meeruth.
SaxenaBSand Gupta R C.SolidState Physics. PragatiPrakasam, Meeruth.
Srivastava B N. EssentialsofQuantumMechanics. PragatiPrakasam, Meeruth.
Vasudeva D N. Fundamentals ofMagnetismand Electricity. S. Chand and Co., New Delhi.

Sr. No.	CourseName	CourseNo.	Credit	L	P	T
3	**Engineering Chemistry**	**Chem(E)-1.1.3**	**3(2 +1)**	**2**	**1**	**0**

Coursecontent:

Theory:

Phaseruleanditsapplicationtooneandtwocomponentsystems.Fuels:classification.calorificvalue. Colloids:classification. properties.Corrosion:causes. typesandmethod ofprevention. Water: temporary andpermanenthardness.disadvantagesofhardwater, scaleandsludgeformationinboilers,boiler corrosion.Analyticalmethods like thermo-gravimetric.Polarographicanalysis.nuclear radiation.detectors andanalyticalapplications ofradioactivematerials.Enzymesand theiruse in themanufacturing ofethanol andaceticacidby fermentationmethods.Principles offoodchemistry.Introductiontolipids,proteins, carbohydrates,vitamins,foodpreseltators,colouring andflavouring reagentsoffood.Lubricants: properties.mechanism.classificationand tests.Polymers.typesofpolymerization.properties.usesand methods for the determination ofmolecularweightofpolymers.Introduction to IRspectroscopy.

Practical:

Determinationoftemporaryandpermanenthardness ofwaterbyEDTAmethod:Estimationofchloridein water:Estimationofdissolvedoxygeninwater:DeterminationofBOD inwatersample:Determinationof COD inwatersample:Estimationofavailable chlorineinbleaching powder:Determinationofviscosity of oil:Estimationofactivity ofwatersample:Estimationofalkalinityofwatersample:Determinationof carbonate and non-carbonatehardness bysoda reagent: Determination of coagulation of water and chloride ion content:Determination ofspecificrotationofanoptically activecompound:Determination of Xnax andverification ofBeerLambertLaw:Determination ofcalorific value of fuel: Identificationof functional groups (alcohol, aldelyde, ketones, carboxylic acid and amide) by IR: Chromatographic analysis:Determination of molar refraction oforganiccompounds.

Planningof lectures

S. No.	Topicsto becoveredin Lecture	Proposed No. of Lectures
1	Phaserule itsapplicationtoone and two componentsystems	2
2	Fuels Classification, Calorific value	2
3	Colloids Classification,properties	2
4	Corrosion:Causes,type and methods ofprevention	2
5	Water:Temporaryand permanenthardness, disadvantagesofhard water	2
6	Scaleandsludgeformationin boilers,boilercorrosion	2
7	Analyticalmethods like thermo-gravimetric.polarographicanalysis	2
8	nuclearradiation. detectorsand analyticalapplicationsof radioactive materials	3
9	Enzymesand theiruse inthe manufacturingofethanoland acetic acidby fermentation methods	3
10	Principlesoffoodchemistry.Introductiontolipids,proteins, carbohydrates, vitamins, foodpreseltators,colorings and flavoringreagents offood	6
11	Lubricants:properties. mechanism.classification andtests	2
12	Polymers. typesofpolymerization. properties. usesandmethods for the determinationofmolecular weightofpolymers.	3
13	Introduction to IRspectroscopy.	1
	Total	**32**

Practicals

S.No.	Topic	No. of Praticals
1	Determination oftemporaryand permanenthardness ofwaterby EDTAmethod	1
2	Estimation ofchloridein water	1
3	Estimation ofdissolved oxygen in water	1
4	Determination ofBOD inwatersample	1
5	Determination ofCOD inwatersample	1

6	Estimation ofavailable chlorine inbleachingpowder	1
7	Determination ofviscosityofoil	1
8	Estimation ofactivityand alkalinityofwatersample	1
9	Determination ofcarbonateand non-carbonate hardnessbysodareagent	1
10	Determination of coagulation ofwaterandchlorideion content	1
11	Determination ofspecific rotationofan opticallyactive compound	1
12	Determination ofλmax and verification ofBeerLambertLaw	1
13	Determination ofcalorific value offuel	1
14	Identification offunctionalgroups (alcohol,aldelyde, ketones, carboxylic acidand amide)by IR	1
15	Chromatographicanalysis	1
16	Determination ofmolarrefraction oforganic compounds	1
	Total	**16**

Jain PL andJain M.1994.EngineeringChemistry.Danpat RaipublishingcompanyPvt. Ltd., Delhi.
BahlBS, Arun BahlandTuliB D. 2007. EssentialsofPhysical Chemistry. S.Chand and Co. Ltd., Delhi

Sr. No.	CourseName	CourseNo.	Credit	L	P	T
4	PrinciplesofSoilScience	Ag(E)-1.1.4	3(2 +1)	2	1	0

Coursecontent:

Theory:

Natureandoriginofsoil;soilformingrocksandminerals,theirclassificationandcomposition,soil forming processes,classificationofsoils– soil taxonomy orders;importantsoilphysicalproperties;and theirimportance;soilparticledistribution;soilinorganiccolloids–theircomposition,propertiesand originofcharge;ion exchangeinsoilandnutrientavailability;soilorganicmatter–itscompositionand decomposition,effectonsoil fertility;soilreaction– acidic,salineandsodicsoils;quality orirrigation water;essentialplantsnutrients–theirfunctionsanddeficiency symptomsinplants;importantinorganic fertilizersand their reactionsinsoils.Use ofsalineandsodicwaterforcropproduction,Gypsum requirement for reclamationofsodicsoilsandneutralising RSC;Liquid fertilisersand theirsolubility and compatibility.

Practical:

Identificationofrocksandminerals;Examinationofsoilprofileinthefield;CollectionofSoilSample; Determinationofbulkdensity;particledensityandporosityofsoil;Determinationoforganiccarbonof soil;DeterminationofNitrogen,Determinationof PhosphorusandDeterminationofPotassium; Identificationofnutrientdeficiencysymptomsofcropsinthefield;Determinationofgypsum requirement ofsodicsoils;Determination ofwaterqualityparameters.

Planningof lectures

S. No.	Topicsto becoveredin Lecture	Proposed No. of Lectures
1	Nature andorigin ofsoil	3
2	soil formingrocks and minerals,theirclassification andcomposition, soil formingprocesses	3
3	classificationofsoils–soiltaxonomyorders; importantsoilphysical properties;and their importance	3
4	soilparticle distribution;soilinorganic colloids–theircomposition, properties and origin ofcharge	3
5	ion exchange in soiland nutrientavailability;soilorganic matter–its composition anddecomposition, effecton soil fertility	3
6	soil reaction– acidic, salineand sodicsoils;qualityorirrigation water	3
7	essentialplantsnutrients–theirfunctionsand deficiencysymptoms in plants	3
8	important inorganicfertilizers and theirreactionsin soils	3
9	Useofsalineandsodic water forcrop production	2
10	Gypsumrequirement forreclamation ofsodic soils andneutralisingRSC	3
11	Liquid fertilisersandtheir solubilityand compatibility	3
	Total	**32**

Practicals

S.No.	Topic	No. of Praticals
1	Identification ofrocks andminerals	2
2	Examination ofsoilprofilein the field	1
3	Collection ofSoilSample	1
4	Determination ofbulk density, particle densityand porosityofsoil	3
5	Determination oforganic carbonofsoil	1
6	Determination ofNitrogen	1
7	Determination ofPhosphorus	1
8	Determination ofPotassium	1
9	Identification ofnutrientdeficiencysymptoms ofcropsin thefield	2
10	Determination ofgypsumrequirementofsodic soils	1
11	Determination ofwaterqualityparameters	2
	Total	**16**

Suggested Readings

BradyNyle C and RayRWell.2002. Nature and properties ofsoils. Pearson Education Inc., New Delhi.
Indian SocietyofSoilScience. 1998. FundamentalsofSoilScience.IARI, New Delhi.
SehgalJ..A.TextbookofPedologyConcepts and Applications.KalyaniPublishers, New Delhi.
HillelD. 1982. Introduction to SoilPhysics. Academic Press, London.

Sr. No.	CourseName	CourseNo.	Credit	L	P	T
5	**Surveying and Levelling**	**CE-1.1.5**	**3(1 +2)**	**1**	**2**	**0**

Coursecontent:

Theory:

Surveying:Introduction,classificationandbasicprinciples,Linearmeasurements.Chainsurveying.Cross staffsurvey,Compasssurvey.Planimeter,Errorsinmeasurements,theireliminationandcorrection.Plane tablesurveying.Levelling,Levelingdifficultiesanderrorinleveling, Contouring,Computationofarea andvolume.Theodolite traversing.Introductiontosettingofcurves.Totalstation,ElectronicTheodolite. Introduction to GPS survey

Practical:

Chain surveyofan areaand preparation ofmap;Compasssurveyofan area andplottingofcompasssurvey;Plane tablesurveying;Levelling. L sectionand Xsections andits plotting;Contoursurveyofan areaand preparation ofcontourmap;Introduction ofsoftwarein drawingcontour;Theodolitesurveying;RangingbyTheodolite, HeightofobjectbyusingTheodolite;SettingoutcurvesbyTheodolite;Minorinstruments. Use of totalstation.

Planningof lectures

S. No.	Topicsto becoveredin Lecture	Proposed No. of Lectures
1	Surveying Introduction	1
2	classificationand basic principlesLinearmeasurements	1
3	Chain Surveying. Compass survey	2
4	Errorsin measurements,theirelimination and correction	1
5	Planetablesurveying.	2
6	Levelling, Levelingdifficulties anderrorinleveling	2
7	Contouring	3
8	Computationofareaand volume	1
9	Theodolite traversing..	2
10	Introduction to settingofcurves	1
	Total	**16**

Practicals

S.No.	Topic	No. of Praticals
1	Measurementofdistance byrangingand chaining.	**2**
2	Locating variousobjects bychain &crossstaffsurveying.	**1**
3	Determination ofarea ofpolygon bychain and cross staffsurvey.	**1**
4	Measurementofbearingsofsidesoftraversewith prismatic compass and computation ofcorrectincluded angle.	**1**
5	Locating given buildingbychainandcompass traversing,	**2**
6	Determination ofelevationofvarious points with dumpylevelbycollimation plane method and rise&fallmethod.	**1**
7	Fixingbench markwith respecttotemporarybench markwith dumpylevelbyfly levelingand checklevelling.	**1**
8	L-Sectionandcrosssectionof road.	**1**
9	Measurementofhorizontalanglestheodolitebysimple method.	**1**
10	Measurementofhorizontalanglestheodolitebyrepetition method	**1**
11	MeasurementofhorizontalanglestheodolitebyReiteration method	**1**
12	Measurementofverticalangleswiththeodolite.	**1**
13	Determination ofhorizontaldistance betweentwoinaccessible points with thedolite.	**1**
14	Locating given building by thedolite traversing.	**2**
15	Plane table survey- Radiation method.	**1**
16	Plane table survey- Intersection method.	**1**
17	Plane table survey- Traversing method.	**1**

18	Locating given building by plain table traversing.	**2**
19	Three point problem in plane table traversing.	**1**
20	Determination of elevation of point by trigonometric levelling.	**1**
21	Contour survy of given area.	**2**
22	Determination of horizontal distance between two inaccessible points with	**1**
23	To prepare Gale's traverse table of a closed traverse	**2**
24	To measure elevation and depression angles	**1**
25	To find the reduced level of base inaccessible point	**1**
26	Carry out survey with with minor instruments	**1**
	Total	**32**

Suggested Readings

Punmia,B C1987. Surveying(Vol.I). LaxmiPublications, New Delhi.
AroraKR 1990. Surveying(Vol.I), Standard BookHouse, Delhi.
Kanetkar TP 1993. Surveyingand Levelling. PuneVidyarthiGriha, Prakashan, Pune.

Sr. No.	CourseName	CourseNo.	Credit	L	P	T
6	EngineeringMechanics	CE-1.1.6	3(2 +1)	2	1	0

Coursecontent:

Theory:

Basic concepts ofEngineeringMechanics. Forcesystems, Centroid, Momentofinertia, Freebodydiagram andequilibrium offorces.FrictionalforcesAnalysisofsimpleframedstructuresusingmethodsofjoints, methodsofsectionsandgraphicalmethod. Simplestresses.Shearforceand bending momentdiagrams. Stresses inbeams. Torsion.Analysis ofplaneandcomplexstresses.

Practical:

Problemsoncompositionandresolutionofforces,momentsofaforce,couples,transmissionofacouple, resolutionofaforceintoaforce& acouple;Problemsrelatingtoresultantof;Co-planerforcesystem, collinear forcesystem,concurrentforcesystem,co-planerconcurrentforcesystem, co-planernon-concurrentforcesystem, Non-coplanerconcurrentforcesystem, Non-coplaner non-concurrentforce system,systemofcouplesinspace;Problemsrelatingtocentroidsofcompositeareas;Problemson momentofinertia,polarmomentofinertia,radiusofgyration,polar radius ofgyrationofcomposite areas; Equilibrium ofconcurrent–co-planerandnonconcurrent–co-planerforcesystems;Problemsinvolving frictionalforces;Analysisofsimpletrussesbymethodofjointsandmethodofsections;Analysisof simpletrussesbygraphicalmethod;Problemsrelating tosimplestressesandstrains;Problemsonshear forceandbendingmomentdiagrams;Problemsrelatingtostressesinbeams;Problemsontorsionof shafts;Analysis ofplaneand complex stresses.

Planningof lectures

S. No.	Topicsto becoveredin Lecture	Proposed No. of Lectures
1	Basicconcepts ofEngineeringMechanics.	2
2	Forcesystems,	2
3	Free bodydiagramand equilibriumof forces	3
4	Centroid,	4
5	Momentofinertia	4
6	Frictional forces	4
7	Analysis ofsimple framed structures usingmethods of joints, methods of sectionsand graphicalmethod.	4
8	Simple stresses. Shear force and bendingmomentdiagrams.	3
9	Stresses inbeams	3
10	Torsion. Analysis ofplaneand complex stresses.	3
	Total	**32**

Practicals

S.No.	Topic	No. of Praticals
1	Problemson composition and resolution offorces, moments ofaforce, couples, transmission ofa couple,resolution ofa forceinto aforce&acouple.	2
2	Problems relatingto resultantof;Co-planerforcesystem, collinearforcesystem, concurrentforcesystem,co-planerconcurrent forcesystem, co-planernon-concurrentforcesystem, Non-coplanerconcurrentforce system, Non-coplanernon-concurrentforcesystem, systemofcouples inspace.	2
3	Problems relatingto centroids ofcompositeareas.	1
4	Problems on momentof inertia, polarmomentofinertia, radiusofgyration, polar radiusofgyrationofcomposite areas.	2
5	Equilibriumofconcurrent – co-planerand nonconcurrent – co-planer force systems.	1
6	Problems involvingfrictionalforces.	1
7	Analysisofsimple trussesby graphicalmethod.	2
8	Problems relatingto simplestressesand strains.	1
9	Problems on shear force and bendingmomentdiagrams.	1

10	Problems relatingto stresses in beams.	1
11	Problems on torsion ofshafts.	1
12	Analysis ofplaneandcomplex stresses.	1
	Total	16

Suggested Readings

Sundarajan V2002. Engineering Mechanics and Dynamics. TataMcGraw HillPublishingCo. Ltd., New Delhi.

Timoshenko S and YoungDH2003. Engineering Mechanics.McGraw HillBookCo.,New Delhi.

Prasad IB2004. AppliedMechanics.Khanna Publishers, New Delhi.

Prasad IB2004. AppliedMechanicsand Strength ofMaterials.Khanna Publishers, New Delhi.

BansalRK2005. ATextBookofEngineeringMechanics. LaxmiPublishers, New Delhi

Sr. No.	CourseName	CourseNo.	Credit	L	P	T
7	**Engineering Drawing**	**ME-1.1.7**	**2(0 +2)**	**0**	**2**	**0**

Coursecontent:

Practical:

Introductionofdrawingscales;Firstandthirdanglemethodsofprojection.Principlesoforthographic projections;Referencesplanes;Pointsand lines in spaceand tracesof linesandplanes;Auxiliary planes and true shapes ofobliqueplain surface;Truelength and inclination oflines;Projections ofsolids (Change ofpositionmethod, alterationofgroundlines);SectionofsolidsandInterpenetrationofsolid surfaces; Developmentofsurfacesofgeometricalsolids; Isometricprojectionofgeometrical solids.Preparationof workingdrawingfrommodelsandisometricviews. Drawingofmissingviews.Differentmethodsof dimensioning. Conceptof sectioning. Revolved and oblique sections.Sectionaldrawingofsimple machine parts.Typesof rivetheadsand riveted joints.Processes forproducing leakproof joints.Symbolsfor different typesofweldedjoints.Nomenclature, threadprofiles,multistartthreads, leftandrighthand threads.Squareheaded andhexagonalnutsandbolts.Conventionalrepresentationof threads.Different typesoflocknuts,studs,machinescrews,capscrews andwoodscrews.Foundationbolts.Formsofscrew threads,representationofthreads,Bolts-headedcentre,studscrews,setscrews,butt,hexagonaland square;keys-types, taper,ranktaper, hollowsaddle etc.

Practicals

S.No.	Topic	No. of Praticals
1	Introduction ofdrawingscales;Differentmethodsofdimensioning	2
2	Firstand third angle methods ofprojection. Principlesoforthographicprojections; Referencesplanes;	2
3	Projection ofPoints, ProjectionofLines tracesoflinesand planes;	2
4	Truelength and inclinationoflines	2
5	Projection ofPlanes	2
6	Traces Auxiliaryplanesand true shapesofoblique plain surface	2
7	Projections ofsolids(Change ofpositionmethod, alteration ofground lines	2
8	Section ofsolids and Interpenetrationofsolid surfaces	2
9	Developmentofsurfaces ofgeometricalsolids	2
10	Isometric projection ofgeometricalsolids, Preparationofworkingdrawingfrom models andisometricviews, Drawingofmissing views	2
11	Conceptofsectioning. Revolved and obliquesections.Sectionaldrawingofsimple machine parts	2
12	Typesofrivetheadsand rivetedjoints. Processes forproducingleakproofjoints. Symbols fordifferent typesofweldedjoints.Nomenclature, thread profiles, multi startthreads, leftandrighthand threads	2
13	Squareheaded and hexagonalnutsand bolts	1
14	Conventionalrepresentation ofthreads	1
15	Differenttypesoflocknuts, studs, machinescrews, capscrews and wood screws. Foundationbolts	2
16	Forms ofscrew threads,representation of threads, Bolts-headed centre, stud screws, setscrews, butt, hexagonaland square	2
17	keys-types, taper,ranktaper, hollowsaddle etc.	2
	Total	**32**

Suggested Readings

BhatN D. 2010. ElementaryEngineeringDrawing. CharotarPublishingHousePvt. Ltd., Anand.
BhattNDand PanchalVM. 2013.Machine Drawing. CharotarPublishingHouse Pvt. Ltd., Anand.
NarayanaKL and Kannaiah P. 2010.Machine Drawing. ScitechPublications(India)Pvt. Ltd., Chennai.

Sr. No.	CourseName	CourseNo.	Credit	L	P	T
8	**Heatand MassTransfer**	**ME-1.1.8**	**2(2 +0)**	**2**	**0**	**0**

Coursecontent:

Theory:

Concept,modesofheattransfer,thermalconductivityofmaterials,measurement.Generaldifferential equationofconduction.Onedimensionalsteadystateconductionthroughplaneandcompositewalls, tubesand sphereswith andwithoutheatgeneration. Electricalanalogy.Insulationmaterials. Fins, Freeand forcedconvection.Newton'slawofcooling,heattransfercoefficientinconvection.Dimensionalanalysis offreeandforcedconvection.Usefulnondimensionalnumbers.Equationoflaminarboundarylayeron flatplateandinatube.Laminarforcedconvectionon aflatplateandinatube.Combinedfreeandforced convection.Introduction. Absorptivity,reflectivity andtransmissivity of radiation. Black body and monochromaticradiation,Planck's law,Stefan-Boltzmanlaw,Kirchoff'slaw, greybodiesandemissive power,solidangle,intensity ofradiation.Radiationexchangebetweenblack surfaces,geometric configurationfactor.Heat transferanalysisinvolving conduction,convectionandradiationby networks. Typesofheatexchangers,fouling factor,logmeantemperaturedifference,heatexchangerperformance, transferunits.Heatexchangeranalysisrestrictedto paralleland counterflowheatexchangers.Steady state moleculardiffusion influidsatrestandin laminarflow,Flick'slaw,masstransfercoefficients.Reynold's analogy.

Planningof lectures

S. No.	Topicsto becoveredin Lecture	Proposed No. of Lectures
1	Introductoryconcepts, modesofheattransfer.	2
2	thermalconductivityofmaterials, measurement Generaldifferentialequation ofconduction. One dimensionalsteadystate conduction through plane and composite walls,tubes and spheres with and withoutheatgeneration. Electricalanalogy	3
3	Insulation materials	2
4	Fins	2
5	Freeand forced convection.Newton's law ofcooling, heattransfer coefficientin convection	3
6	Dimensionalanalysis offree andforced convection	2
7	Usefulnon dimensionalnumbers and empirical relationships forfree and forced convection	2
8	Equation oflaminarboundarylayeronflatplate and in a tube	2
9	Laminar forcedconvectionon a flatplate andin atube	1
10	Combined free andforced convection	1
11	Introduction. Absorptivity,reflectivityand transmissivityof radiation. Black bodyand monochromatic radiation, Planck'slaw, Stefan-Boltzman law, Kirchoff'slaw, greybodiesand emissive power, solidangle, intensityof radiation	2
12	Radiation exchange between blacksurfaces, geometricconfiguration factor	1
13	Heattransferanalysis involvingconduction, convection and radiation by networks	2
14	Typesofheatexchangers, foulingfactor,logmean temperature difference,heat exchangerperformance, transferunits	2
15	Heatexchangeranalysisrestricted to paralleland counterflowheat Exchangers	2
16	Steady state molecular diffusion in fluids at rest and in laminar flow, Flick's law, mass transfer coefficients. Reynold's analogy	3
	Total	**32**

Suggested Readings

Geankoplis C.J. 1978.TransportPortProcesses and UnitOperations. Allyn and Bacon Inc., Newton, Massachusetts.

Holman JP. 1989. HeatTransfer.McGraw HillBookCo., New Delhi.

Incropera F Pand DeWittDP. 1980. Fundamentals ofHeatandMassTransfer.John Wileyand Sons, New York.

Gupta C Pand Prakash R.1994. EngineeringHeatTransfer. NemChand and Bros., Roorkee.

Sr. No.	CourseName	CourseNo.	Credit	L	P	T
9	NSS/NCC/Physical Education	Phy. Edu.-1.1.9	0(0 +1)	0	0	0

SEMESTER – II

Sr. No.	CourseName	CourseNo.	Credit	L	P	T
1	EngineeringMathematics-II	Math(E)-1.2.1	3(2 +1)	2	1	0

Coursecontent:

Theory:

Ordinarydifferentialequations:ExactandBernoulli'sdifferentialequations,equationsreducibletoexact formbyintegratingfactors,equationsoffirstorderandhigherdegree,Clairaut'sequation,Differential equationsofhigherorders,methodsoffindingcomplementaryfunctionsandparticularintegrals,method ofvariationofparameters,Cauchy'sandLegendre'slinearequations,simultaneous lineardifferential equationswith constantcoefficients,seriessolution techniques,Bessel'sand Legendre'sdifferential equations.Functionsofa Complexvariable:Limit, continuity andanalyticfunction,Cauchy-Riemann equations,Harmonicfunctions.Infiniteseries anditsconvergence,periodicfunctions,Fourierseries, Euler'sformulae,Dirichlet'sconditions,functionshaving arbitrary period,evenandoddfunctions,half rangeseries,Harmonicanalysis.FourierSineandCosineSeries,Fourierseriesforfunctionhavingperiod 2L,Elimination ofoneandtwoarbitrary function. Partialdifferentialequations:Formationofpartial differentialequationsHigherorderlinearpartialdifferentialequationswithconstantcoefficients,solution ofnon-linearpartialdifferentialequations,Charpit'smethod,applicationofpartialdifferentialequations (onedimensionalwave andheatflowequations, LaplaceEquation.

Tutorial:

Tutorialsonsolutionofordinarydifferentialequationsoffirstandhigherorders.Seriessolutionsof differential equations. Bessel's and Legendre'sdifferentialequations, Convergence ofinfiniteseries. Fourierseries,harmonic analysis, analytical functions,Cauchey-Riemannequations, harmonicfunctions, Solutionofpartialdifferentialequations, Application ofpartialdifferentialequations.

Planningof lectures

S. No.	Topicsto becoveredin Lecture	Proposed No. of Lectures
1	Exactand Bernoulli's differentialequations, equationsreducibletoexact formby integratingfactors, equations offirstorderand higherdegree, Clairaut'sequation	3
2	Differentialequations ofhigherorders, methods offindingcomplementary functions and particularintegrals, methodofvariationofparameters	4
3	Cauchy's andLegendre'slinearequations, simultaneous lineardifferential equations with constantcoefficients, Bessel'sand Legendre's differentialequations	3
4	Seriessolution techniques	3
5	FunctionsofaComplex variable:Limit,continuityandanalyticfunction	2
6	Cauchy-Riemann equations, Harmonic functions	3
7	Fourierseries, Euler's formulae, Dirichlet'sconditions,functions havingarbitrary period, even and oddfunctions, halfrange series, Harmonic analysis. FourierSine and CosineSeries, Fourierseriesforfunction havingperiod 2L, periodic functions	5
8	Partialdifferentialequations:Formation ofpartialdifferentialequations, Elimination ofone andtwoarbitraryfunctions,Higherorderlinearpartial differentialequations withconstantcoefficients	5
9	Solutionofnon-linearpartialdifferentialequations, Charpit's method	2
10	Application ofpartialdifferentialequations(onedimensionalwave andheatflow equations, Laplace Equation)	2
	Total	**32**

Tutorials

S.No.	Topic	No. of Praticals
1	Solutionofordinarydifferentialequations offirstandhigherorders	2
2	Seriessolutions ofdifferentialequations	3
3	Bessel'sand Legendre's differentialequations	1
4	Convergence ofinfiniteseries	1

5	Fourierseries,harmonic analysis	3
6	Analyticalfunctions, Cauchey-Riemann equations, harmonic functions	3
7	Solutionofpartialdifferentialequations, Application ofpartialdifferential equations.	3
	Total	16

Suggested Readings

Narayan Shanti.2004. ATextBookof Matrices. S. Chand and Co. Ltd. New Delhi.
GrewalBS.2004. HigherEngineeringMathematics.Khanna Publishers Delhi.
RamanaBV. 2008. Engineering Mathematics.Tata McGraw-Hill. New Delhi

Sr. No.	CourseName	CourseNo.	Credit	L	P	T
2	**EnvironmentalScienceand Disaster Management**	**AS(E)-1.2.2**	**3(2 +1)**	**2**	**1**	**0**

Coursecontent:

Theory: ***Environmental Studies:***Scopeand importance. Natural Resources: Renewable and non-renewableresources Naturalresourcesandassociatedproblems.a)Forestresources:Useandover-exploitation,deforestation, casestudies. Timberextraction,mining,damsandtheireffectsonforestand tribalpeople.b)Water resources:Useandover-utilizationofsurfaceandgroundwater, floods,drought, conflictsoverwater,dams-benefits andproblems. c) Mineralresources:Useandexploitation, environmentaleffectsofextractingandusingmineralresources,casestudies.d)Food resources:World foodproblems,changescausedby agriculture andovergrazing,effects ofmodernagriculture, fertilizer-pesticideproblems,waterlogging,salinity,casestudies.e)Energyresources: Growingenergyneeds, renewableandnon-renewableenergy sources,useofalternateenergy sources.Casestudies. f)Land resources:Land asa resource, landdegradation, maninduced landslides, soilerosion anddesertification. Roleofan individualin conservationofnatural resources.Equitableuseof resources for sustainable lifestyles.Ecosystems:Concept,Structure, function, Producers, consumers,decomposers,Energy flow, ecologicalsuccession, foodchains,foodwebs, ecologicalpyramids.Introduction,types, characteristic features, structure and function of the forest, grassland, desertand aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries). Biodiversity andits conservation:- Introduction, definition, genetic, species&ecosystem diversityand bio-geographicalclassificationofIndia.Valueofbiodiversity: consumptive use, productive use, social, ethical, aesthetic and option values. Biodiversity atglobal, Nationaland local levels, Indiaasamega-diversity nation.Hot-sportsofbiodiversity. Threats to biodiversity:habitatloss,poachingofwildlife,man-wildlifeconflicts. Endangeredandendemicspecies ofIndia.Conservation ofbiodiversity:In-situand Ex-situconservation ofbiodiversity.Environmental Pollution:definition,cause,effectsandcontrolmeasuresofa.Airpollutionb. Waterpollutionc.Soil pollutiond.Marinepollutione.Noisepollutionf. Thermalpollutiong.Nuclearhazards.SolidWaste Management:causes, effects and controlmeasuresofurban and industrialwastes. Role ofan individualin preventionofpollution.Pollutioncasestudies.SocialIssuesandtheEnvironmentfrom Unsustainableto Sustainabledevelopment, Urbanproblemsrelated to energy.Waterconservation,rain waterharvesting, watershedmanagement.Environmentalethics:Issuesandpossiblesolutions, climate change,global warming, acid rain, ozone layerdepletion, nuclearaccidents and holocaust. dies. Wasteland reclamation. Consumerism andwasteproducts.EnvironmentProtectionAct.Air(PreventionandControlofPollution) Act.Water (PreventionandcontrolofPollution)Act.WildlifeProtectionAct. ForestConservationAct. Issuesinvolvedinenforcementofenvironmentallegislation.Publicawareness. HumanPopulationandthe Environment:population growth,variationamongnations,populationexplosion,Family Welfare Programme.Environmentandhumanhealth:Human Rights,ValueEducation, HIV/AIDS.Womenand ChildWelfare. Role ofInformationTechnologyin Environmentand human health.

DisasterManagement:

NaturalDisastersandnatureofnaturaldisasters, their typesandeffects.Floods,drought,cyclone, earthquakes,landslides,avalanches,volcaniceruptions,Heatandcoldwaves,Climaticchange:global warming,Sealevelrise,ozonedepletion.ManMadeDisasters- Nucleardisasters,chemicaldisasters, biologicaldisasters,buildingfire,coalfire,forestfire,oilfire,airpollution,waterpollution,deforestation, industrialwastewaterpollution, roadaccidents,railaccidents,airaccidents, seaaccidents.Disaster Management- Effecttomigratenaturaldisasteratnationalandgloballevels.Internationalstrategy for disasterreduction.Conceptofdisastermanagement,nationaldisastermanagementframework;financial arrangements;roleofNGOs,community-basedorganizationsandmedia.Central, state,districtand local administration;Armed forces indisasterresponse;Disasterresponse;Police and otherorganizations

Practicals

Case Studies and Field work. Visit to a local area to document environmental assets river/forest/grassland/hill/mountain, Visit toa localpolluted site-Urban/Rural/Industrial/Agricultural, study ofcommonplants, insects,birdsandstudy ofsimpleecosystems-pond,river,hillslopes,etc. Expected impactofclimate changeon agriculturalproduction andwaterresources,MitigationStrategies, Economicsofclimate change.DisasterManagementintroduction,NaturalandManmadeDisasterStudies, Informatics forDisaster Management,QuantitativeTechniques forDisaster ManagementEnvironmental ImpactAssessment(EIA)andDisasterManagementDisasterManagementPolicy Environmental Modelling.

Planningof lectures

S. No.	Topicsto becoveredin Lecture	Proposed No. of Lectures
1	Scope and importance	1
2	NaturalResources:Renewable and non-renewableresources	1
3	Naturalresourcesand associated problems	1
4	a)Forestresources	1
5	b)Waterresources	1
6	c)Mineralresources	1
7	d)Foodresources	1
8	e)Energyresources	1
9	f)Land resources	1
10	Roleofanindividualinconservationofnaturalresources.Equitableuseof resourcesforsustainable lifestyles	1
11	Equitable use ofresources forsustainablelifestyles	1
12	Ecosystems	1
13	Functionoftheforest,grassland,desertandaquaticecosystems(ponds,streams, lakes, rivers, oceans, estuaries)	1
14	Biodiversityand its conservation	1
15	Value ofbiodiversity	1
16	Hot-sports ofbiodiversity. Threatsto biodiversity	1
17	Conservation ofbiodiversity	1
18	EnvironmentalPollution	1
19	SolidWasteManagement	1
20	Role ofanindividualin prevention ofpollution. Pollution case studies Social Issues and the Environment from Unsustainable to Sustainable development, Urban problems related to energy	1
21	Waterconservation, rainwaterharvesting, watershedmanagement	1
22	Environmental ethics: Issues and possible solutions, climate change, global warming, acid rain, ozonelayerdepletion,nuclearaccidentsand holocaust. dies	1
23	Wastelandreclamation. Consumerismand waste products	1
24	Environment ProtectionAct. Air (Prevention and Control of Pollution) Act. Water(PreventionandcontrolofPollution)Act.WildlifeProtectionAct.Forest Conservation Act.	1
25	Issues involved in enforcementofenvironmentallegislation. Publicawareness	1
26	HumanPopulationandtheEnvironment:populationgrowth,variationamong nations,populationexplosion, FamilyWelfare Programme	1
27	Environmentandhumanhealth:HumanRights,ValueEducation,HIV/AIDS., Women and Child Welfare	1
28	RoleofInformationTechnologyin Environmentandhuman health.	1

29	NaturalDisastersandnatureofnaturaldisasters,theirtypesandeffects,Floods, drought, cyclone, earthquakes, landslides, avalanches, volcanic eruptions, Heat and cold waves, Climatic change: global warming, Sea level rise, ozone depletion	1
30	ManMadeDisasters-Nucleardisasters,chemicaldisasters,biologicaldisasters, building fire, coal fire, forest fire, oil fire, air pollution, water pollution, deforestation,industrialwastewaterpollution,roadaccidents,railaccidents,air accidents, seaaccidents	1
31	DisasterManagement-Effecttomigratenaturaldisasteratnationalandglobal levels. Internationalstrategyfordisasterreduction.	1
32	Concept of disaster management, national disaster management framework; financial arrangements; role of NGOs, community-based organizations and media.Central,state,districtandlocaladministrationArmedforcesindisaster response;Disasterresponse;Policeand otherorganizations	1
	Total	**32**

Practicals

S.No.	Topic	No. of Praticals
1	CaseStudiesandFieldwork.Visittoalocalareatodocumentenvironmentalassets river/forest/grassland/hill/mountain,	3
2	Visit toa localpollutedsite-Urban/Rural/Industrial/ Agricultural,	3
3	Studyofcommonplants,insects,birdsandstudyofsimpleecosystems-pond,river, hillslopes, etc.	2
4	Expectedimpactofclimatechangeonagriculturalproductionandwaterresources, Mitigation Strategies	2
5	Economicsofclimate change.	1
6	DisasterManagement introduction,	1
7	Naturaland ManmadeDisasterStudies	1
8	InformaticsforDisasterManagement,	1
9	QuantitativeTechniquesforDisasterManagementEnvironmentalImpact Assessment(EIA)	1
10	DisasterManagementDisasterManagementPolicyEnvironmentalModelling.	1
	Total	**16**

Suggested Readings

Bharucha Erach. 2005.TextBookofEnvironmentalStudiesforUndergraduate Courses. UniversityGrants Commission, UniversityPress, Hyderabad.

Sharma JP. 2003. IntroductiontoEnvironmentScience. LakshmiPublications.

CharyManoharandJaya RamReddy. 2004. PrinciplesofEnvironmentalStudies.BS Publishers, Hyderabad.

KaulS N, Ashuthosh Gautam. 2002. WaterandWasteWaterAnalysis. Days PublishingHouse, Delhi.

Gupta PK. 2004. Methodsin EnvironmentalAnalysis– Water.SoilandAir.Agro bios,Jodhpur.

Climate change.1995:Adaptationand mitigationofclimate change-ScientificTechnicalAnalysis Cambridge UniversityPress, Cambridge.

Sharma, R.K. &Sharma, G. 2005. NaturalDisaster. APHPublishingCorporation,New Delhi.

HusainMajid.2013. Environmentand Ecology:Biodiversity, Climate Change and DisasterManagement. online book

r. No.	CourseName	CourseNo.	Credit	L	P	T
3	**Entrepreneurship Developmentand BusinessManagement**	**AS(E)-1.2.3**	**3 (2 +1)**	**2**	**1**	**0**

Coursecontent:

Theory

Entrepreneurship,management–Managementfunctions–planning-Organizing-Directing–motivation –ordering–leading–supervision-Communicationandcontrol– Capital –Financialmanagement– importanceof financialstatements–balance sheet–profitandlossstatement,Analysisof financial statements– liquidity ratios–leverageratios,Coverageratios– turnover ratios– profitability ratios,Agro-basedindustries–Project– projectcycle–Projectappraisalandevaluationtechniques–undiscounted measures–paybackperiod–proceedsperrupeeofoutlay,Discountedmeasures–NetPresentValue (NPV)–Benefit-CostRatio(BCR)–InternalRateofReturn (IRR)–Netbenefitinvestmentratio (N/ K ratio)–sensitivity analysis-ImportanceofagribusinessinIndianeconomyInternationaltrade-WTO agreements–Provisionsrelatedtoagreementsinagriculturalandfood commodities.Agreementson agriculture(AOA)–Domesticsupply,marketaccess,exportsubsidiesagreementsonsanitary andphyto-sanitary(SPS)measures,Traderelatedintellectualpropertyrights(TRIPS).Development(ED):Concept ofentrepreneurandentrepreneurshipAssessing overallbusiness environmentinIndianeconomy–Entrepreneurialandmanagerialcharacteristics- EntrepreneurshipdevelopmentProgrammes(EDP)-Generationincubationandcommercializationofideasandinnovations- Motivationandentrepreneurship development- Globalizationandtheemergingbusinessentrepreneurialenvironment- Managingan enterprise: Importance of planning, budgeting, monitoring evaluation and follow-up managing competition.RoleofEDineconomicdevelopmentofacountry- OverviewofIndiansocial,political systemsandtheirimplicationsfordecisionmakingbyindividualentrepreneurs- Economicsystemandits implicationsfordecisionmakingbyindividualentrepreneurs-Socialresponsibilityofbusiness.Morals andethicsinenterprisemanagement- SWOTanalysis- Governmentschemesandincentivesforpromotion ofentrepreneurship.Governmentpolicyonsmallandmedium enterprises(SMEs)/SSIs/MSMEsectors-Venturecapital(VC),contractfarming (CF)and jointventures(JV),public-privatepartnerships (PPP)-Overview of agricultural engineeringindustry, characteristicsofIndian farmmachineryindustry.

Practical

Preparationofbusiness–StrengthsWeaknessesOpportunitiesand Threats (SWOT)analysis, Analysis offinancialstatements (BalanceSheet,Profit lossstatement).Compounding anddiscounting,Break-even analysisVisittoagro-basedindustries–I,Visittoagro-basedindustries–IIStudy ofAgro-industries DevelopmentCorporation,Ratioanalysis–I, Ratioanalysis–II,Applicationofprojectappraisal technique–I(Undiscountedmeasures), Applicationof projectappraisaltechnique–II(Discounted Measures),Formulationofprojectfeasibilityreports–FarmMachineryProjectproposalsasentrepreneur – individualand group-Presentationofprojectproposalsinthe class.

Planningof lectures

S. No.	Topicsto becoveredin Lecture	Proposed No. of Lectures
1	Introduction to entrepreneurship andmanagement	1
2	Management functions – planning-OrganizingDirecting –motivation– ordering– leading–supervision	1
3	Communicationand control– Capital	1
4	Financialmanagement– importanceoffinancialstatements– balance sheet – profitandlossstatement	1
5	Analysis offinancialstatements– liquidity ratios–leverage ratios	1
6	Analysis offinancialstatements– Coverage ratios– turnoverratios– profitabilityratios	1
7	Agro-based industries– Project	2
8	Projectcycle– Projectappraisaland evaluationtechniques–	1
9	undiscounted measures– paybackperiod– proceeds per rupeeofoutlay,	1
10	Discountedmeasures – NetPresentValue(NPV)– Benefit-CostRatio (BCR)	2

	– InternalRateofReturn (IRR)– Netbenefit investmentratio (N/K ratio)– sensitivityanalysis	
11	Importance ofagribusinessin Indian economy Internationaltrade-WTO agreements– Provisions relatedto agreements in agriculturalandfood commodities.	1
12	Agreements on agriculture(AOA)– Domesticsupply, marketaccess, export subsidiesagreements on sanitaryand phyto-sanitary (SPS) measures,Trade related intellectual propertyrights (TRIPS).	2
13	Development (ED): Conceptofentrepreneurand entrepreneurship	1
14	Assessingoverallbusinessenvironment inIndian economy	1
15	Entrepreneurialand managerialcharacteristics	1
16	Entrepreneurship developmentProgrammes(EDP)	1
17	Generation incubation andcommercialization of ideasand innovations-Motivation andentrepreneurship development	1
18	Globalization and the emergingbusinessentrepreneurialenvironment	1
19	Managingan enterprise:Importanceofplanning, budgeting, monitoring evaluationand follow-upmanagingcompetition	1
20	Role ofEDineconomic developmentofacountry-Overview of Indiansocial, politicalsystems andtheirimplicationsfordecision makingbyindividual entrepreneurs	1
21	Economicsystemand itsimplicationsfordecision makingbyindividual entrepreneurs	1
22	Socialresponsibilityofbusiness. Morals and ethicsinenterprise management	1
23	SWOT analysis-Governmentschemesandincentivesforpromotion of entrepreneurship	1
24	Governmentpolicyon smalland mediumenterprises(SMEs)/SSIs/MSME sectors	1
25	Venture capital(VC)contractfarming(CF) andjointventures(JV)	1
26	public-private partnerships(PPP)	1
27	Overview of agriculturalengineeringindustry	1
28	CharacteristicsofIndian farmmachineryindustry	2
	Total	**32**

Practical

S.No.	Topic	No. of Practicals
1	Planning, analysis and preparationofbusiness proposal	1
2	A study on Strengths Weaknesses Opportunities and Threats (SWOT) analysis	1
3	Astudyon analysisoffinancialstatements(Balance Sheet, Profit loss statement)	1
4	Astudyon Compoundingand discounting	1
5	Astudyon Break-even analysis	1
6	Visit toagro-based industries– I	1
7	Visit toagro-based industries– II	1
8	AstudyofAgro-industriesDevelopmentCorporation	1
9	Astudyon Ratio analysis–I	1
10	Astudyon Ratio analysis– II	1
11	Application ofprojectappraisaltechnique– I(Undiscounted measures)	1
12	Application ofprojectappraisaltechnique– II(DiscountedMeasures)	1
13	Formulation ofprojectfeasibilityreports– Projectproposals regarding Agribusiness/AgriculturalEngineeringasentrepreneur– individual/group	2
14	Presentation ofprojectproposals inthe class	2
	Total	**16**

Suggested Readings

Harsh, S.B., Conner, U.J. and Schwab, G.D. 1981. Managementof theFarmBusiness. PrenticeHallInc., New Jersey.

Joseph, L. Massie. 1995. EssentialsofManagement. Prentice HallofIndia Pvt. Ltd., New Delhi.

OmriRawlins, N. 1980. Introduction toAgribusiness.Prentice HallInc., NewJersey

GittengerPrice,J. 1989. Economic Analysis ofAgriculturalProjects.John Hopkins University, Press, London.

ThomasW Zimmerand Norman MScarborough. 1996. Entrepreneurship.Prentice-Hall, NewJersey.

MarkJDollinger. 1999. Entrepreneurship Strategiesand Resources.Prentice-Hall, UpperSaddalRover, New Jersey.

Khanka S S. 1999. Entrepreneurial Development. S. Chand and Co. New Delhi.

MohantyS K. 2007. Fundamentals ofEntrepreneurship. Prentice HallIndia Ltd.,New Delhi.

Sr. No.	CourseName	CourseNo.	Credit	L	P	T
4	**FluidMechanics andOpen Channel Hydraulics**	**CE-1.2.4**	**3(2 +1)**	**2**	**1**	**0**

Coursecontent:

Theory:

Propertiesoffluids:Idealandrealfluid.Pressureanditsmeasurement,Pascal'slaw,pressureforceson planeandcurvedsurfaces,centreofpressure,buoyancy,metacentreandmetacentricheight,conditionof floatationandstabilityofsubmergedandfloatingbodies;Kinematicsoffluidflow:Lagrangianand Euleriandescriptionoffluidmotion,continuityequation,pathlines,streaklinesandstreamlines,stream function, velocitypotential and flow net. Types of fluid flow, translation, rotation, circulation and vorticity, Vortexmotion; Dynamicsoffluidflow,Bernoulli'stheorem,venturimeter,orificemeterand nozzle,siphon;Laminarflow:Stressstrain relationships,flow between infiniteparallelplatesbothplates fixed, one plate moving, discharge, average velocity; Laminar and turbulent flow in pipes, general equationforheadlossDarcy,Equation,Moody'sdiagram,Minorandmajorhydrauliclossesthrough pipesandfittings,flowthroughnetworkofpipes,hydraulicgradientandenergygradient;Flowthrough orifices (Measurement of Discharge, Measurement of Time),Flow through Mouthpieces, Flow over Notches,Flowoverweirs, Chezy'sformulaforlossofheadinpipes,Flowthroughsimpleandcompound pipes, Open channel design and hydraulics: Chezy's formula, Bazin's formula, Kutter's Manning's formula,Velocity andPressureprofiles inopenchannels,Hydraulic jump;Dimensionalanalysisand similitude:Rayleigh's methodand Buckingham's`Pi'theorem,types of similarities,dimensionalanalysis, dimensionless numbers. Introduction to fluid machinery.

Practical

Studyofmanometers andpressure gauges;Verification ofBernoulli's theorem;Determination ofcoefficientofdischarge ofventuri-meterand orifice meter;Determination ofcoefficientoffriction in pipeline;Determination ofcoefficientofdischarge forrectangularandtriangularnotch;Determinationof coefficientofdischarge, coefficientofvelocityand coefficientofcontractionfor flowthrough orifice; Determination ofcoefficientofdischarge formouth piece;Measurementofforceexerted bywaterjets on flatand hemisphericalvanes;Determinationofmeta-centricheight;Determination ofefficiencyof hydraulic ram;Performance evaluation ofPelton andFrancisturbine;Studyofcurrentmeter;Velocity distributionin open channels and determination ofManning's coefficientofrugosity.

Planningof lectures

S. No.	Topicsto becoveredin Lecture	Proposed No. of Lectures
1	Propertiesoffluids:Idealand realfluid.	2
2	Pressureandits measurement, Pascal'slaw, pressure forceson planeand curved surfaces, centre ofpressure,buoyancy, meta centre andmeta centric height, condition offloatationandstabilityofsubmerged andfloatingbodies	4
3	Kinematicsoffluidflow	2
4	Dynamicsoffluidflow	2
5	Bernoulli's theorem	1
6	Venturimeter,orificemeterand nozzle, siphon;	1
7	Laminarflow:Stressstrainrelationships, flowbetweeninfiniteparallelplates both platesfixed, one platemoving, discharge, average velocity;	4
8	Laminar andturbulentflowinpipes, general equationforheadloss Darcy, Equation	3
9	Moody's diagram, Minorand majorhydrauliclosses through pipesand fittings, flowthrough networkofpipes, hydraulic gradientandenergy gradient	4
10	Flow through orifices,Flowthrough Mouthpieces, FlowoverNotches , Flow overweirs, Chezy's formula forlossofhead inpipes,Flow through simple and compound pipes	3
11	Open channeldesign and hydraulics.	1
12	Velocityand Pressure profilesin openchannels, Hydraulicjump;	1

13	Dimensionalanalysisand similitude:Rayleigh's method and Buckingham's `Pi' theorem, typesofsimilarities, dimensionalanalysis,dimensionlessnumbers	3
14	Introduction to fluid machinery.	1
	Total	**32**

Practicals

S.No.	Topic	No. of Praticals
1	Studyofmanometers and pressure gauges;	1
2	Verification ofBernoulli'stheorem;	1
3	Determination ofcoefficientofdischarge ofventuri-meterand orificemeter;	1
4	Determination ofcoefficientoffrictioninpipeline	1
5	Determination ofcoefficientofdischarge forrectangularand triangularnotch	1
6	Determination ofcoefficientofdischarge, coefficientofvelocityand coefficientof contraction forflow through orifice;	2
7	Determination ofcoefficientofdischarge formouth piece;	1
8	Measurementofforce exerted bywaterjets on flatandhemisphericalvanes;	2
9	Determination ofmeta-centricheight	1
10	Determination ofefficiencyofhydraulic ram	1
11	Performance evaluation ofPelton andFrancis turbine;	1
12	Studyofcurrentmeter;	1
13	Velocitydistribution inopen channels and determination ofManning's coefficient of rugosity	2
	Total	**16**

Suggested Readings

Sundarajan V2002. Engineering Mechanics and Dynamics. TataMcGraw HillPublishingCo. Ltd.,New Delhi.

enko S and YoungDH2003. Engineering Mechanics.McGraw HillBookCo., New Delhi.

Prasad IB2004. AppliedMechanics.Khanna Publishers, New Delhi.

Prasad IB2004. AppliedMechanicsand Strength ofMaterials.Khanna Publishers, New Delhi.

BansalRK2005. ATextBookofEngineeringMechanics. LaxmiPublishers, New Delhi

Sr. No.	CourseName	CourseNo.	Credit	L	P	T
5	**Strength ofMaterials**	**CE-1.2.5**	**2(1 +1)**	**1**	**1**	**0**

Coursecontent:

Theory

Slopeanddeflectionofbeamsusingintegrationtechniques,momentareatheoremsandconjugatebeam method.ColumnsandStruts.Rivetedandweldedconnections.Stability ofmasonry dams.Analysisof staticallyintermediatebeams.Proppedbeams.Fixedandcontinuousbeamanalysisusingsuperposition, threemomentequation andmomentdistribution methods.

Practical

Toperformthetensiontestonmetalspecimen(M.S.,C.I.),toobservethebehaviorofmaterialsunder load,tocalculatethevalue ofE,ultimatestress,permissiblestress,percentageelongationetc.andtostudy its fracture; To perform the compression test on; Concrete cylinders &cubes, C.I., M.S. &Wood specimensandtodeterminevariousphysicalandmechanicalproperties;Toperformthebendingteston thespecimens;M.S.Girder,Woodenbeam,Plainconcretebeams&R.C.C.beam,andtodeterminethe variousphysicalandmechanicalproperties; TodetermineYoung'smodulusofelasticityofbeam withthe helpof deflection produced at centre duetoloadsplacedatcentre&quarter points;To studythe behaviourofmaterials(G.I.pipes,M.S.,C.I.)undertorsionandtoevaluatevariouselasticconstants;To study load deflection and other physical properties of closely coiled helical spring in tension and compression; Toperform theRockwell, Vicker'sandBrinell'sHardnesstestsonthegivenspecimens;To performtheDropHammerTest,IzodTestandCharpay'simpacttestsonthegivenspecimens;To determinecompressive&tensilestrengthof cementaftermakingcubesandbriquettes;Tomeasure workability ofconcrete(slumptest,compaction factortest);To determinevoids ratio&bulk density of cement,fineaggregatesandcoarseaggregates;Todeterminefatiguestrengthofagivenspecimen;To writedetailreportemphasizingengineeringimportanceofperformingtension,compression,bending, torsion,impactand hardness testson the materials.

Planningof lectures

S. No.	Topicsto becoveredin Lecture	Proposed No. of Lectures
1	Slopeanddeflectionofbeams usingintegrationtechniques	2
2	Momentareatheorems andconjugate beammethod	2
3	Columns and Struts	1
4	Riveted and welded connections	2
5	Stabilityofmasonrydams	2
6	Analysis ofstaticallyintermediate beams	2
7	Proppedbeams	2
8	Fixedand continuous beamanalysis usingsuperposition	1
9	Threemomentequationand momentdistribution methods	2
	Total	**16**

Practicals

S.No.	Topic	No. of Praticals
1	To performthetensionteston metalspecimen (M.S.,C.I.), to observe thebehaviourofmaterialsunderload, tocalculate the value ofE, ultimate stress, permissiblestress,percentage elongation etc.andto studyits fracture.	1
2	To performthe compression teston;Concrete cylinders &cubes,C.I., M.S. &Woodspecimensand to determine various physicaland mechanicalproperties	1
3	To performthe bendingteston thespecimens;M.S. Girder,Wooden beam, Plainconcrete beams &R.C.C. Beam, and to determine the various physicalandmechanicalproperties	1
4	To determineYoung's modulus ofelasticityofbeamwiththehelp of deflectionproducedatcentre due toloads placed atcentre&quarterpoints	1

5	Tostudythe behaviourofmaterials(G.I. pipes, M.S.,C.I.)undertorsion andto evaluate various elastic constants	1
6	Tostudyload deflectionand otherphysicalpropertiesofcloselycoiled helical springin tension and compression	1
7	To performthe Rockwell,Vicker'sand Brinell's Hardnesstests on the given specimens	1
8	To performthe Drop HammerTest, Izod Testand Charpay'simpact tests onthe given specimens	1
9	To determine compressive&tensilestrength ofcementaftermaking cubesand briquettes	3
10	To measure workabilityofconcrete (slump test, compactionfactortest)	2
11	To determine voidsratio &bulkdensityofcement, fine aggregatesand coarseaggregates	1
12	To determine fatigue strength ofa given specimen.	1
13	To write detailreportemphasizingengineeringimportanceofperforming tension,compression, bending, torsion,impactand hardness testson the materials	1
	Total	**16**

Suggested Readings

KhurmiR.S. 2001. Strength ofMaterials S. Chand &Co., Ltd., New Delhi.
JunarkarS.B. 2001.MechanicsofStructures (Vo-I). ChoratarPublishingHouse, Anand.
RamamruthamS. 2003. Strengths of Materials. DhanpatRaiand Sons, NaiSarak, New Delhi.

Sr. No.	CourseName	CourseNo.	Credit	L	P	T
6	**Work shop Technology and Practices**	**ME-1.2.6**	**3(1 +2)**	**1**	**2**	**0**

Coursecontent:

Theory:

Introductiontovariouscarpentrytools,materials,typesofwoodandtheircharacteristicsandProcessesor operationsin wood working;Introduction to Smithytoolsand operations;Introduction to welding, typesof welding,Oxyacetylenegaswelding,typesofflames,welding techniquesandequipment.Principleofarc welding,equipmentandtools.Castingprocesses;Classification,constructionaldetailsofcenterlathe, Mainaccessoriesandattachments.Mainoperations andtoolsusedoncenterlathes. Typesofshapers, Constructionaldetailsofstandardshaper.Workholdingdevices,shapertoolsandmainoperations.Types ofdrilling machines.Constructionaldetailsofpillartypesandradialdrilling machines.Work holding and toolholding devices. Mainoperations.Twistdrills,drillanglesandsizes. Typesandclassification. Constructionaldetailsand principlesofoperationofcolumnandkneetypeuniversalmillingmachines. Plain millingcutter.Main operations on millingmachine.

Practical:

Preparationofsimplejoints:CrosshalfLapjointandT-Halvingjoint;PreparationofDovetailjoint, Mortise and tenor joint; Jobs on Bending, shaping etc.; Jobs on Drawing, Punching, Rivetting. Introductionto toolsandmeasuring instruments for fitting;Jobsonsawing,filing andrightangle fitting of MSFlat;Practicalinmorecomplexfittingjob;Operationsofdrilling,,reaming,andthreadingwithtap anddies;Introductiontotoolsandoperationsinsheetmetalwork;Makingdifferenttypesofsheetmetal jointsusingG.I. sheets. Introductionto weldingequipment, processes tools,theiruseandprecautions;Jobs onARCwelding–Lapjoint,buttjoint;T-JointandcornerjointinArcwelding;Gaswelding Practice–Lab,buttandT-Joints;Introductiontometalcastingequipment,toolsandtheiruse;Mouldmaking using one-piecepattern and two piecespattern;Demonstrationofmouldmaking using sweeppattern,andmatch plate patterns; Introduction to machine shop machines and tools; Demonstration on Processes in machininganduseofmeasuringinstruments;Practicaljobsonsimpleturning,stepturning;Practicaljob ontaperturning,drillingandthreading;Operationsonshaperandplaner,changingaroundMSrodinto squaresectiononashaper;Demonstrationofimportantoperationsonamilling machine,makingaplot, gear tooth formingand indexing;Anyadditionaljob.

Planningof lectures

S. No.	Topicsto becoveredin Lecture	Proposed No. of Lectures
1	Introductiontovariouscarpentrytools,materials,typesofwoodandtheir characteristics, Processes oroperations inwood working;	1
2	Introduction to Smithytools and operations.	1
3	Introductiontowelding,typesofweldingOxyacetylenegaswelding,typesof flames, welding techniques and equipment. Principle ofarc welding, equipmentand tools.	2
4	Castingprocesses;Classification,constructionaldetailsofcenterlathe,Main accessoriesandattachments.	2
5	Mainoperations andtoolsused oncenter lathes.	2
6	Typesofshapers, Constructionaldetailsofstandard shaper.	1
7	Workholdingdevices, shapertools and main operations.	1
8	Typesofdrillingmachines.	1
9	Constructionaldetails ofpillartypesand radialdrillingmachines.	1
10	Workholdingandtoolholdingdevices.Main operations. Twistdrills,drill anglesand sizes.	1
11	Typesand classification. Constructionaldetails ofcolumn and knee type universalmillingmachines	1
12	Principlesofoperation ofcolumn and knee type universalmillingmachines.	1
13	Plain millingcutter.Main operations on millingmachine	1
	Total	**16**

Practicals

S.No.	Topic	No. of Practical
1	To understand and preparea layoutofworkshop	2
2	Introduction to toolsand measuringinstruments forcarpentry	2
3	Preparationofsimplejobsusingcarpentrytools	2
4	Introduction to toolsand measuringinstruments forfitting	2
5	Preparationofsimplejobsusingfittingtools	2
6	Introduction to toolsand measuringinstruments forsheetmetalwork	2
7	Preparationofsimplejobsusingsheetmetalworkwith G.I. sheet	2
8	Introduction to differenttools and equipments ofweldingmachine	2
9	Demonstration ofajobin arc welding	2
10	Introductionto metalcastingequipment, toolsand theiruse	2
11	Prepare amould cavitybyusingdifferentcastingequipments.	4
12	Introduction to machineshop and differentcuttingtools	2
13	Demonstration ofajob on lathe machine	2
14	Demonstration ofajobondrillingmachine	2
15	Demonstration ofajob on shapermachine	2
	Total	**32**

Suggested Readings

Hazra, ChoudariSKand BoseSK. 1982. Elements ofWorkshoptechnology (Vol. IandII). Media Promotersand Publishers Pvt.Ltd.,Mumbai.

Chapman WAJ.1989.WorkshopTechnology(PartIand II). Arnold Publishers(India)Pvt. Ltd., AB/9 SafdarjungEnclave, NewDelhi.

RaghuwamsiBS. 1996. ACourseinWorkshopTechnology(Vol. Iand II). DhanpatRaiandSons,1682 NaiDarak, New Delhi

Sr. No.	CourseName	CourseNo.	Credit	L	P	T
7	**Theory ofMachines**	**ME-1.2.7**	**2(2 +0)**	**2**	**0**	**0**

Coursecontent:

Theory:

Elements,links,pairs,kinematicschain,andmechanisms.Classificationofpairsandmechanisms.Lower andhigherpairs.Fourbarchain,slidercrank chain andtheirinversions.Determinationofvelocity and accelerationusing graphical(relativevelocity andacceleration)method.Instantaneouscenters.Typesof gears.Lawofgearing,velocityofslidingbetweentwoteethinmesh.Involuteandcycloidalprofilefor gearteeth.Spurgear,nomenclature,interferenceandundercutting.Introductiontohelical,spiral,bevel andwormgear.Simple,compound,reverted,andepicyclictrains.Determining velocityratiobytabular method.Turning momentdiagrams,coefficientoffluctuationofspeed andenergy,weightof flywheel, flywheelapplications.Beltdrives,typesofdrives,beltmaterials.Lengthofbelt,powertransmitted, velocityratio,beltsizeforflatandVbelts.Effectofcentrifugaltension, creepandsliponpower transmission,Chaindrives.Typesoffriction,lawsofdryfriction.Frictionofpivotsandcollars.Single disc,multipledisc,andconeclutches.Rolling friction,antifrictionbearings.Typesofgovernors. Constructionaldetailsand analysisofWatt,Porter,Proellgovernors.Effectoffriction,controlling force curves.Sensitiveness, stability,hunting,iso-chronism,powerand effortofa governor. Staticanddynamic balancing. Balancingofrotating massesin one anddifferentplanes.

Planningof lectures

S. No.	Topicsto becoveredin Lecture	Proposed No. of Lectures
1	Introduction to elements,links, pairs, kinematicchainand mechanism. Classification ofpairs, mechanismandtheirinversion	3
2	Determination ofvelocityand acceleration using graphicalmethod and instantaneous centers	4
3	Typesofgearsandlaw of gearing, involutesand cycloidalprofile for gear teeth,spurgearnomenclature, introduction tohelical,spiral, bevel and wormgear, simple, compound, revertedandepicyclic train	4
4	Determination ofvelocity ratio bytubularmethod, turningmoment diagram, coefficientoffluctuationofspeedandenergy, flywheelandits application	4
5	Typesofbeltdrives, beltmechanism, beltmaterials, lengthofbelts, powertransmitted, velocityratio,effectofcentrifugal tension, creepand slip, chain drive	4
6	Typesoffriction,law ofdryfriction, friction ofpivotsand collars	2
7	Single disc, multiple disc and coneclutches,rollingfriction and antifriction bearing	3
8	Typesofgovernors,constructionaldetailsandanalysis ofwatt,porter, proellgovernors	3
9	Effectoffriction,controllingforcecurve, sensitiveness, stability, hunting, isochronisms, powerand effectofgovernors	3
10	Staticand dynamic balancing, balancingofrotatingmassin oneand differentplanes	2
	Total	**32**

Suggested Readings

Bevan Thomas. 1984.TheoryofMachines. CBS Publishers and Distributors,Delhi.

BallaneyP L. 1985.TheoryofMachines.KhannaPublishers, 2-B Nath Market, NaiSarak, New Delhi.

RaoJS and DukkipattiRV. 1990. Mechanisms andMachineTheory. Wileyastern Ltd., New Delhi.

LalJagdish. 1991.TheoryofMechanisms andMachines. Metropolitan BookCo.Pvt.Ltd., 1 NetajiSubash Marg, New Delhi..

Rattan S B. 1993.TheoryofMachines.TataMcGrawHillPublishingCo. Ltd.,12/4 AsafAliRoad, New Delhi.

iRS and GuptaJ K.1994.TheoryofMachines.Eurasia PublishingHousePvt. Ltd., RamNagar, New Delhi.

Sr. No.	CourseName	CourseNo.	Credit	L	P	T
8	**Web Designing and Internet Applications**	**CSE-1.2.8**	**2 (1 +1)**	**1**	**1**	**0**

Coursecontent:

Theory: Basicprinciples indeveloping awebdesigning, Planning process, FiveGoldenrulesofweb designing, Designing navigationbar, Pagedesign,HomePageLayout, Design Concept. Basics in Web Design, BriefHistoryofInternet, WorldWideWeb,creationof awebsite, WebStandards,Audience requirement.IntroductiontoJavaScript,variables&functions,Workingwithalert,confirmandprompt, ConnectivityofWeb pageswith databases;Project

Practical:

FLASH:AnimationconceptFPS,Understandinganimationforweb,Flashinterface,Working with tools, DREAM WEAVER :Exploring Dreamweaver Interface, Planning &Setting Web Site Structure, Working withpanels,Understanding and switching views,Using property inspector,Formatting text,JAVASCRIPT:Workingwithalert,confirm andprompt,Understanding loop,arrays,Creating rolloverimage,Working withoperator,GIFANIMATION:LearningtouseFTP, SettingFTP,Uploading ofsite,UsingControlpanel,FTPUPLOADINGSITE:Understandinggifanimationinterface,Knowing GIffileformat,Creating basic webbanners,Creating webbannerswith effects, Creating animatedweb buttons

Planningof lectures

S. No.	Topicsto becoveredin Lecture	Proposed No. of Lectures
1	BriefHistoryofInternet	1
2	Introduction ofWWW,Website, Web serverand Webclient	1
3	Web design concepts, principalsand standards	2
4	BasicofHTML &Dreamviewer	3
5	Introduction toJavaScript, variables	1
6	Workingwithalert, confirmand prompt	1
7	JavaScriptconditionalstatementand looping	3
8	JavaScriptEvents andFormElements	3
9	ConnectivityofWeb pageswith databases	1
Total		**16**

Practicals

S.No.	Topic	No. of Tutorials
1	Introduction ofDREAM WEAVER windowslayouts&menu	1
2	DREAM WEAVER: Planning&SettingWeb SiteStructure	1
3	DREAM WEAVER:Textformatting, Listing&Table	2
4	DREAM WEAVER:Image properties &Linking	1
5	DREAM WEAVER: Frame and partition tags	1
6	FTP Uploading& Downloading	1
7	JavaScript:Introduction, variableand operators	2
8	JavaScript:alert, confirmand promptdialogboxes	1
9	JavaScript:ConceptofFormElements &events	2
10	JavaScript:Creatingrolloverimage	1
11	FLASH:Introduction and layouts	1
12	FLASH Animation:Motion and shapetween	1
13	GIFImage & Animated button	1
	Total	**16**

Suggested Readings

JenniferNiederstRobbins.Developingweb design latestedition.
Frainand Ben. Responsive WebDesign withHTML5..
Nicholasc.Zakas. Java Script forWeb Developers.
George Q. Huang, K. LMak.InternetApplications inProductDesign and Manufacturing.
ISBN:3540434658.

Sr. No.	CourseName	CourseNo.	Credit	L	P	T
9	NSS/NCC/Physical Education	Phy. Edu.-1.2.9	0(0 +1)	0	0	0

SEMESTER – III

Sr. No.	CourseName	CourseNo.	Credit	L	P	T
1	PrinciplesofHorticulturalCrops and PlantProtection	Ag(E)-2.3.1	2(1 +1)	1	1	0

Coursecontent:

Theory:

Scope ofhorticultural. Soil and climatic requirements for fruits, vegetables and floriculture crops, improvedvarieties, Criteriaforsite selection, layoutandplanting methods,nursery raising,commercial varieties/hybrids,sowingandplantingtimesandmethods,seedrateandseedtreatmentforvegetable crops;macroandmicro propagationmethods,plantgrowing structures,pruning andtraining,crop coefficients,water requirementsandcriticalstages, fertilizerapplication, fertigation, irrigationmethods, harvesting, grading and packaging, post harvest practices, Garden tools, management of orchard, Extraction and storageofvegetables seeds. Majorpestsand diseasesand theirmanagementinhorticulture crops.

Practical

Judgingmaturitytimeforharvestingofcrop;Studyofseedviabilityandgerminationtest;Identification and description of important fruits, flowers and vegetable crops; Study of different garden tools; Preparationofnurserybed;Practicesofpruningandtraininginsomeimportantfruitcrops,visitto commercialgreenhouse/polyhouse;culturaloperationsforvegetablecrops(sowing,fertilizerapplication, mulching,irrigationandweedcontrol);seedextractiontechniques; identificationof importantpestsand diseases andtheircontrol.

Planningof lectures

S. No.	Topicsto becoveredin Lecture	Proposed No. of Lectures
1	Scope ofhorticultural.	1
2	Soiland climatic requirementsforfruits, vegetablesand floriculture crops, improved varieties	1
3	Criteriaforsiteselection,layoutand plantingmethods,nurseryraising, commercialvarieties/hybrids, sowingand plantingtimesand methods	2
4	Seed rate andseedtreatment forvegetable crops;	1
5	Macro andmicro propagation methods,	1
6	Plantgrowingstructures, pruningandtraining,	2
7	Crop coefficients, waterrequirementsandcriticalstages, fertilizerapplication, fertigation,irrigation methods,	2
8	Harvesting, gradingand packaging, postharvestpractices,.	2
9	Gardentools, managementoforchard,	1
10	Extractionand storage ofvegetablesseeds.	2
11	Majorpests anddiseasesand theirmanagement in horticulturecrops	1
	Total	**16**

Practicals

S.No.	Topic	No. of Praticals
1	Judging maturitytime forharvestingofcrop;	1
2	Studyofseed viabilityand germinationtest;	2
3	Identificationand description ofimportantfruits,flowers and vegetable crops;.	2
4	Studyofdifferentgardentools;	1
5	Preparationofnurserybed;	1
6	Practicesofpruningand traininginsome importantfruitcrops,	2
7	Visit tocommercialgreenhouse/polyhouse;	2
8	Culturaloperations forvegetablecrops (sowing, fertilizerapplication, mulching,	2
	irrigation and weed control);	

9	Seed extraction techniques;	2
1	Identification of important pests and diseases and their control	1
	Total	**16**

Suggested Readings

Bansal. P.C. 2008. Horticulturein India. CBS Publishers and Distributors, NewDelhi.

Saraswathy, S.,T.L.Preethi, S.Balasubramanyan, J. Suresh, N.Revathyand S.Natarajan. 2007. Postharvest managementofHorticulturalCrops. Agrobios Publishers,Jodhpur.

Arjunan, G.,Karthikeyan, G, Dinakaran , D.and Raguchander,T. 1999. DiseasesofHorticulturalCrops. AE Publications, Coimbatore.

Sharma NeetaandMashkoorAlam. 1997. Postharvestdiseases ofHorticulturalcrops. International Book publishingCo. UP.

Sr. No.	CourseName	CourseNo.	Credit	L	P	T
2	PrinciplesofAgronomy	Ag(E)-2.3.2	3(2 +1)	2	1	0

Coursecontent:

Theory:

Introduction and scope ofagronomy. Classification ofcrops, Effectofdifferentweatherparameters on cropgrowthand development. Principles oftillage, tilth and itscharacteristics. Crop seasons.Methods, time and depth ofsowingofmajorfield crops.Methods andtime ofapplication ofmanuresandfertilizers. Organic farming-Sustainable agriculture.Soilwaterplantrelationship, cropcoefficients, water requirementofcropsand criticalstagesforirrigation,weeds and theircontrol,crop rotation,cropping systems, Relaycroppingand mixed cropping.

Practical

Identification ofcropsandtheirvarieties,seeds, manures, fertilizers and weeds;Fertilizerapplication methods;Differentweed controlmethods;Practice ofploughing, PracticeofPuddling,Practice ofsowing.

Planningof lectures

S. No.	Topicsto becoveredin Lecture	Proposed No. of Lectures
1	Introduction and scope ofagronomy	2
2	Classification ofcrops	2
3	Effectofdifferentweatherparameters oncrop growthand development	3
4	Principlesoftillage, tilthand its characteristics	4
5	Crop seasons	4
6	Methods,time and depthofsowingofmajorfieldcrops	4
7	Methodsand time ofapplication ofmanuresand fertilizers	3
8	Organic farming-Sustainable agriculture	3
9	Soilwaterplant relationship, cropcoefficients, waterrequirementofcrops and criticalstages forirrigation	3
10	Weeds andtheircontrol, crop rotation,croppingsystems	4
11	Relaycroppingand mixedcropping	
	Total	**32**

Practicals

S.No.	Topic	No. of Practicals
1	Identification ofcropsandtheirvarieties,seeds, manures, fertilizers and weeds;.	4
2	Fertilizerapplication methods;	2
3	Differentweed controlmethods;	4
4	Practice ofploughing,	2
5	Practice ofPuddling,	2
6	Practice ofsowing	2
	Total	**16**

Suggested Readings

WilliamL Donn. 1965.Meteorology. McGraw-HillBookCo. New York.

Arnon L. 1972. CropProduction inDryRegions. Leonard HillPublishingCo. London.

YawalkarKSandAgarwalJP.1977.ManuresandFertilizers.AgriculturalHorticulturalPublishing House, Nagpur.

GuptaOP.1984.ScientificWeedManagementintheTropicsandSub-Tropics.TodayandTomorrow's Printers and Publishers. New Delhi.

Rao VS.1992. Principles ofWeed Science. Oxfordand IBHPublishingCo. Ltd.New Delhi.

ReddyYellamandaTand ShankarReddyG H. 1995. PrinciplesofAgronomy. KalyaniPublishers

Sr. No.	CourseName	CourseNo.	Credit	L	P	T

3	**CommunicationSkillsand PersonalityDevelopment**	**AS(E)-2.3.3**	**2(1 +1)**	**1**	**1**	**0**

Coursecontent:

Theory:

Communication Skills:Structuraland functionalgrammar;meaning andprocessofcommunication,verbal and non-verbalcommunication;listeningand notetaking, writingskills, oralpresentationskills;field diary andlabrecord;indexing,footnoteandbibliographicprocedures.Readingandcomprehensionofgeneral and technical articles, precis writing, summarizing, abstracting; individual and group presentations, impromptu presentation, publicspeaking;Group discussion. Organizingseminars and conferences. **Practical** Listeningandnotetaking,writingskills,oralpresentationskills;fielddiaryandlabrecord;indexing, footnoteandbibliographicprocedures.Readingandcomprehensionofgeneralandtechnicalarticles, precis writing, summarizing, abstracting; individualand group presentations.

Planningof lectures

S. No.	Topicsto becoveredin Lecture	Proposed No. of Lectures
1	Communication Skills:Structuralandfunctionalgrammar	4
2	processofcommunication	1
3	verbaland non-verbalcommunication	2
4	listeningand notetaking	1
5	writingskills	1
6	oralpresentation skills,individualand group presentations, impromptu presentation, public speaking	2
7	indexing, footnote andbibliographicprocedures	1
8	Readingandcomprehension ofgeneralandtechnicalarticles	1
9	precis writing, summarizing, abstracting	1
10	Group discussion	1
11	Organizingseminars and conferences	1
Total		**16**

Tutorials

S.No.	Topic	No. of Tutorials
1	Listeningand note taking	2
2	writingskills	2
3	oralpresentation skills,individualand group presentations	6
4	Indexing, footnote and bibliographicprocedures.	2
5	Readingandcomprehension ofgeneralandtechnicalarticles	2
6	precis writing,summarizing, abstracting	2
	Total	**16**

Suggested Readings

BalasubramanianT. 1989.ATextbookofPhoneticsforIndian Students. OrientLongman, New Delhi.

BalasubrmanyamM. 1985.BusinessCommunication.VaniEducationalBooks, New Delhi.

Naterop,Jean, B.and RodRevell. 1997.Telephoningin English. Cambridge UniversityPress, Cambridge.

MohanKrishnaand MeeraBanerjee.1990. DevelopingCommunication Skills. Macmillan India Ltd. New Delhi.

Krishnaswamy,. Nand Sriraman, T. 1995. CurrentEnglish forColleges. Macmillan India Ltd.Madras.

NarayanaswamyVR. 1979. Strengthen yourwriting. OrientLongman, New Delhi.

Sharma R Cand Krishna Mohan. 1978. Business Correspondence.TataMcGrawHill publishing Company,New Delhi.

Sr. No.	CourseName	CourseNo.	Credit	L	P	T
4	EngineeringMathematics-III	Math(E)-2.3.4	3(2 +1)	2	1	0

Coursecontent:

Theory:

NumericalanalysisandLaplacetransformation: finitedifference,variousdifference operatorsandtheir relationships.factorialnotation,interpolationwith equalintegrals.Newton'sforwardandbackward interpolationformula.Bessel'sandStirling'sdifferenceinterpolationformulae.Interpolationwithunequal intervals. Newton's divided difference formula. Lagrange's interpolation formula. numerical differentiations,numerical integrations,differenceequationsandtheir solutions,numericalsolutionsof ordinary differentialequationsby Picard's Taylor'sseries.Fuller's andmodified Fuller'smethods.Runga-Kuttamethod;Laplacetransformationanditsapplicationsto thesolutionsofordinary andsimultaneous differentialequations.Testing ofHypothesis-LevelofSignificance-Degreesof freedom-Statisticalerrors, Largesampletest(Z-test), Smallsampletestt-test(Onetailed,two tailedandPairedtests), Testing of Significance through variance (F-test), Chi-Square test, contingencytable, Correlation,Regression.

Tutorial:

Interpolation,Numerical differentiationandintegrationsolutionsofdifferenceequations,numerical solutionofordinarydifferentialequationsoffirstorderandfirstdegree,LaplaceandinverseLaplace transformationsand theirapplicationto solutionofordinary andsimultaneousdifferentialequations. ProblemsonOneSample,Twosample Z-testswhenPopulationS.D.isknownandunknown,Problems ononesample,Twosampleandpairedt-testChi-Squaretest–2x2andmxn,CalculationofCorrelation coefficientand itstesting, ContingencyTable and F-test.

Planningof lectures

S. No.	Topicsto becoveredin Lecture	Proposed No. of Lectures
1	Finite difference, various differenceoperators and theirrelationships. factorial notation	3
2	Interpolation with equalintegrals. Newton's forward and backwardinterpolation formula. Bessel's andStirling's difference interpolation formulae	4
3	Interpolation with unequal intervals. Newton's divideddifference formula. Lagrange's interpolationformula.	2
4	numericaldifferentiations,numericalintegrations	2
5	difference equationsandtheirsolutions	2
6	Numericalsolutions ofordinarydifferentialequationsbyPicard'sTaylor's series. Fuller'sand modified Fuller's methods. Runga-Kutta method	3
7	Laplacetransformationanditsapplications tothesolutions ofordinaryand simultaneousdifferentialequations	4
8	TestingofHypothesis-LevelofSignificance-Degrees of freedom-Statistical errors	4
9	Large sample test(Z-test),Smallsample testt-test(One tailed, twotailed and Paired tests)	4
10	TestingofSignificance through variance (F-test), Chi -Squaretest, contingency table, Correlation, Regression	4
	Total	**32**

Tutorials

S.No.	Topic	No. of Tutorials
1	Interpolation	2
2	Numericaldifferentiation and integration	1
3	solutions ofdifferenceequations	1
4	numericalsolution ofordinarydifferentialequations offirstorderand firstdegree	2

5	Laplaceand inverseLaplace transformations and theirapplication tosolution of ordinaryandsimultaneousdifferentialequations.	3
6	Problems on One Sample,Two sample Z-tests whenPopulation S.D. is known and unknown	2
7	Problems on onesample, Two sample and pairedt-test Chi-Square test – 2x2andm x n	2
8	CalculationofCorrelationcoefficientand itstesting	2
9	ContingencyTable and F-test.	1
	Total	16

Suggested Readings

ChandelSRS. A Hand bookofAgriculturalStatistics.AchalPraskasamMasndir,Kanpur.
AgrawalBL. Basic Statistics. WileyEastern Ltd. NewAgeInternationalLtd.
Nageswara Rao G. Statistics forAgriculturalSciences.BS Publications.
RangaswamyR. ATextBookofAgriculturalStatistics. New Age Int. publications Ltd.
Gupta S.C. FundamentalApplied Statistics.

Sr. No.	CourseName	CourseNo.	Credit	L	P	T
5	**SoilMechanics**	**CE-2.3.5**	**2(1 +1)**	**1**	**1**	**0**

Coursecontent:

Theory

Introductionofsoilmechanics,fieldofsoilmechanics,phasediagram,physicalandindexpropertiesof soil,classificationofsoils,effectiveandneutralstress,elementaryconceptofBoussinesqandWester guardsanalysis,newmarkinfluencechart.SeepageAnalysis;Quickcondition-twodimensionalflow-Laplaceequation,Velocitypotentialandstreamfunction,Flownetconstruction.Shearstrength,Mohr stresscircle,theoreticalrelationshipbetweenprinciplestresscircle, theoreticalrelationshipbetween principalstress, Mohrcoulomb failure theory, effective stress principle. Determination ofshearparameters bydirectsheartest,triangletest&vanesheartest. Numericalexercisebasedonvarioustypesoftests. Compaction,compositionofsoilsstandardandmodifiedprotectortest,abbotcompactionandJodhpur minicompaction testfield compactionmethod andcontrol.Consolidationofsoil:Consolidationofsoils, one dimensional consolidation spring analogy, Terzaghi's theory, Laboratory consolidation test, calculationofvoid ratio and coefficientofvolumechange,Taylor's and Casagrande'smethod, determination of coefficient of consolidation. Earthpressure:plasticequilibriumin soils,active and passivestates,Rankine'stheory ofearthpressure,activeandpassiveearthpressureforcohesivesoils, simplenumericalexercises.Stabilityofslopes:introductiontostabilityanalysisofinfiniteandfinite slopes friction circle method, Taylor's stabilitynumber.

Practical

Determination ofwatercontentofsoil;Determinationofspecific gravityofsoil; Determination offield densityofsoilbycorecuttermethod;Determination offield densitybysand replacementmethod;Grain size analysis by sieving(Drysieve analysis);Grain size analysis byhydrometermethod;Determinationof liquidlimitbyCasagrande's method;Determination ofliquidlimitbyconepenetrometerand plasticlimit; Determination ofshrinkage limit; Determination ofpermeabilitybyconstantheadmethod;Determination ofpermeabilityby variablehead method;Determination ofcompactionpropertiesbystandard proctortest; Determination ofshearparameters byDirectsheartest;Determination ofunconfined compressive strength ofsoil;Determinationofshearparameters byTri-axialtest;Determination ofconsolidation properties of soils.

Planningof lectures

S. No.	Topicsto becoveredin Lecture	Proposed No. of Lectures
1	Introduction ofsoilmechanics,fieldofsoilmechanics.	1
2	Phasediagramphysicalandindexpropertiesofsoil.	1
3	Classification ofsoils, generalclassification based on particlessize, texturalclassificationand I. S. Soilclassification system.	1
4	Stresscondition in soils, effective and neutralstress	1
5	ElementaryconceptofBousinesqueandWesterguardsanalysis, Newmarkinfluence chart.	1
6	ShearstrengthMohrstresscircle, theoreticalrelationship between principlestress circle,theoretical relationship betweenprincipalstress	2
7	Mohr-coulomb failure theory, effective stress principle.	1
8	Determination ofshearparameters bydirectsheartothe circle,theoretical test, numericalexercisebased on varioustypesoftests	1
9	Compaction composition ofsoilsstandard and modified protectortest AbbotCompaction andJodhpurminicompactiontextfield compaction method and control	2
10	Consolidation ofsoilConsolidation ofsoils, one dimensionalconsolidation springanalogy	1
11	Terzaghi'stheoryLaboratoryconsolidation test, calculation ofvoid ratio and coefficientofvolume change	1
12	Taylor's and Casagrande's method, determination of coefficient of consolidation	1

13	Earth pressure Plastic equilibrium in soils, active and passive states, Rankine's theory of earth pressure active and passive earth pressure for	1
14	Stability of slopes Introduction to stability analysis of infinite and finite slopes friction circles method Taylor's stability number	1
	Total	**16**

Practicals

S.No.	Topic	No. of Praticals
1	Determination ofwatercontentofsoil.(Various methods)	1
2	Determination ofspecific gravityofsoil	1
3	Determination offielddensityofsoilbycorecuttermethod	1
4	Determination of fielddensitybysand replacementmethod	1
5	Grainsize analysis bysieving(Drysieve analysis)	1
6	Grainsize analysis byhydrometermethod	1
7	Determination ofliquidlimitbyCasagrande's method	1
8	Determination ofliquidlimitbyconepenetrometerandplastic limit	1
9	Determination ofshrinkage limit.	1
10	Determination ofpermeabilitybyconstanthead method	1
11	Determination ofpermeabilityby variable head method	1
12	Determination ofcompaction propertiesbystandard proctortest	1
13	Determination ofshearparameters bydirectsheartest	1
14	Determination ofunconfined compressive strength ofsoil	1
15	Determination ofshearparameters byTri-axialtest	1
16	Determination ofconsolidationpropertiesofsoils	1
	Total	16

Suggested Readings

Punmia B C, Jain AKandJain AK. 2005. SoilMechanicsand Foundations. LaxmiPublications(P) Ltd. New Delhi.

Ranjan Gopaland Rao ASR. 1993. Basicand AppliedSoilMechanics.WelleyEasters Ltd., New Delhi.

Singh Alam. 1994. SoilEngineeringVol.I. CBS Publishers and Distributions, Delhi.

Sr. No.	CourseName	CourseNo.	Credit	L	P	T
6	**Design ofStructures**	**CE-2.3.6**	**2(1 +1)**	**1**	**1**	**0**

Coursecontent:

Theory

LoadsanduseofBISCodes.Designofconnections.Designofstructuralsteelmembersintension, compressionandbending.Designofsteelrooftruss.Analysisanddesignofsinglyanddoublyreinforced sections,Shear,BondandTorsion.DesignofFlangedBeams,Slabs,Columns,Foundations,Retaining wallsand Silos, Cattle shed, PoultryHouse, RuralWaterSupply, Farmfencing.

Practical

Design and drawingofsingle reinforcedbeam, double reinforced beam, Design and drawingofsteelroof truss;Design anddrawingofone way, two wayslabs,Design and drawingofRCCbuilding;Design and drawingofRetainingwall.To measure workabilityofcementbyslump test

Planningof lectures

S. No.	Topicsto becoveredin Lecture	Proposed No. of Lectures
1	Loads and use ofBIS Codes.	1
2	Design ofconnections.	2
3	Design ofstructuralsteelmembers intension,compressionand bending.	3
4	Design ofsteelroof truss.	2
5	Analysisand design ofsinglyand doublyreinforcedsections, Shear, Bond and Torsion.	3
6	Design ofFlanged Beams, Slabs,Columns, Foundations, Retainingwalls and Silos	3
7	Cattle shed, PoultryHouse,RuralWaterSupply, Farmfencing	2
	Total	**16**

Practicals

S.No.	Topic	No. of Praticals
1	Design and drawingofsingle reinforcedbeam, doublereinforcedbeam,	4
2	Design and drawingofsteel rooftruss;	4
3	Design and drawingofoneway, two wayslabs,	3
4	Design and drawingofRCCbuilding;	2
5	Design and drawingofRetainingwall.	2
6	To measure workabilityofcementbyslump test	1
	Total	**16**

Suggested Readings

Junarkar,S.B. 2001.MechanicsofStructuresVol. ICharotarPublishingHome, Anand.

KhurmiR. S. 2001. Strength ofmaterials. S. Chand &CompanyLtd., 7361, Ram Nagar, New Delhi–110055.

KumarSushil2003.Treasure of R.C.C. Design. R.K.Jain. 1705-A, NaiSarak,Delhi-110006, P.B.1074.

Sr. No.	CourseName	CourseNo.	Credit	L	P	T
7	**Machine Design**	**ME-2.3.7**	**2(2 +0)**	**1**	**1**	**0**

Coursecontent:

Theory

Meaningofdesign,Phasesofdesign,designconsiderations.Commonengineeringmaterialsandtheir mechanicalproperties.Typesofloadsandstresses,theoriesoffailure,factorofsafety, selectionof allowablestress.Stressconcentration.Elementaryfatigueandcreepaspects.Cotterjoints,knucklejoint andpinnedjoints,turnbuckle.Designofweldedsubjectedtostaticloads.Designofthreadedfasteners subjectedtodirectstaticloads,boltedjointsloadedinshearandboltedjointssubjectedtoeccentric loading.Designofshaftsundertorsionandcombinedbendingandtorsion.Designofkeys.Designof muff,sleeve,and rigidflangecouplings.Designofhelicaland leafsprings.Designofflatbeltand V-belt drivesandpulleys.Designofgears.Designofscrewmotionmechanismslikescrew jack,leadscrew,etc. Selection ofanti-friction bearings.

Planningof lectures

S. No.	Topicsto becoveredin Lecture	Proposed No. of Lectures
1	Meaningofdesign, Phasesofdesign, design considerations.	2
2	Common engineeringmaterialsand theirmechanicalproperties.	2
3	Typesof loadsand stresses,theoriesof failure, factorofsafety, selection of allowablestress.	2
4	Stressconcentration. Elementary fatigue and creep aspects.	2
5	Cotterjoints, knucklejointand pinnedjoints, turnbuckle.	3
6	Design ofweldedsubjectedto staticloads.	2
7	Design ofthreaded fasteners subjectedto directstaticloads, boltedjointsloaded in shearand boltedjoints subjectedtoeccentric loading.	4
8	Design ofshafts under torsion and combined bending and torsion.	3
9	Design ofkeys. Design ofmuff, sleeve, and rigid flange couplings.	3
10	Design ofhelicalandleafsprings.	2
11	Design offlatbeltandV-beltdrivesand pulleys.	3
12	Design ofgears. Design ofscrew motion mechanisms like screwjack, lead screw,etc. Selection ofanti-friction bearings.	4
	Total	**32**

Suggested Readings

Jain RK. 2013.Machine Design. Khanna Publishers, 2-B Nath Market, NaiSarak, New Delhi.
KhurmiRS and GuptaJ K.2014. ATextBookofMachine Design. S. Chand &CompanyLtd., New Delhi.

Sr. No.	CourseName	CourseNo.	Credit	L	P	T
8	**Thermodynamics, Refrigeration and Air Conditioning**	**ME-2.3.8**	**3(2 +1)**	**2**	**0**	**1**

Coursecontent:

Theory

Thermodynamicsproperties,closedandopensystem,flowandnon-flowprocesses,gaslaws,lawsof thermodynamics,internalenergy.Applicationoffirstlawinheating andexpansionofgasesinnon-flow processes.Firstlawappliedtosteady flowprocesses.Carnotcycle,Carnottheorem.Entropy,physical conceptofentropy,changeofentropy ofgases inthermodynamicsprocess.Otto,dieselanddualcycles. Principlesofrefrigeration,- units,terminology,productionoflow temperatures,airrefrigeratorsworking onreverseCarnotcycleandBellColemancycle. Vapour refrigeration-mechanism,P-V,P-S,P-Hdiagrams, vaporcompression cycles, dry andwetcompression, supercooling andsubcooling. Vapourabsorption refrigeration system. Common refrigerantsand their properties. Design calculationsfor refrigeration system.Coldstorageplants. Thermodynamicpropertiesofmoistair,perfectgasrelationshipfor approximatecalculation,adiabaticsaturationprocess,wetbulbtemperature anditsmeasurement, psychometricchartanditsuse,elementary psychometricprocess.Airconditioning–principles–Typeand functionsofairconditioning, physiologicalprinciples in airconditioning, airdistribution and ductdesign methods,fundamentalsofdesignofcompleteairconditioning systems–humidifiersanddehumidifiers– coolingloadcalculations, typesofairconditioners–applications.

Practical

Tutorialsonthermodynamicaircycles, StudyandapplicationofPVandTSchartinrefrigeration,PH chart (or)Mollierdiagram in refrigeration,Numericalon air refrigeration cycle systems,Numericalon vapourcompression cycle refrigeration system,Study ofdomesticwatercooler,Study ofdomestic householdrefrigerator,Studyofabsorptiontypesolarrefrigerationsystem, Studycoldstorageforfruit andvegetables,Freezing loadandtimecalculations for foodmaterials,Determinationof refrigeration parametersusingrefrigerationtutor–II, Numericalondesignofairconditioningsystems, Studyof windowairconditioner,Study onrepairandmaintenanceof refrigerationandair-conditioning systems. Visit tochillingoricemakingand coldstorage plants.

Planningof lectures

S. No.	Topicsto becoveredin Lecture	Proposed No. of Lectures
1	Thermodynamicsproperties, closedand open system	2
2	flowand non-flowprocesses, gas laws,lawsofthermodynamics, internalenergy	2
3	Application offirstlawin heatingand expansion ofgases innon-flowprocesses.	2
4	Firstlaw applied to steady flowprocesses.	2
5	Carnotcycle, Carnottheorem.	2
6	Entropy, physicalconceptofentropy, change ofentropyofgases in thermodynamicsprocess.	2
7	Otto, dieseland dualcycles.	2
8	Principlesofrefrigeration,-units, terminology, production of lowtemperatures, airrefrigerators workingon reverse Carnotcycle andBellColeman cycle.	2
9	Vapourrefrigeration-mechanism, P-V,P-S,P-Hdiagrams,vaporcompression cycles, dryand wetcompression, supercoolingand sub cooling.	2
10	Vapourabsorptionrefrigerationsystem.	2
11	Common refrigerantsandtheirproperties. Design calculations forrefrigeration system. Cold storage plants	2
12	Thermodynamic propertiesofmoistair,perfectgasrelationship forapproximate calculation, adiabaticsaturationprocess, wetbulbtemperature andits measurement, psychometric chartanditsuse,elementarypsychometric process.	3
	Airconditioning– principles–Type andfunctions ofairconditioning,	2
	physiological principles in air conditioning, air distribution and duct design	
	fundamentals of design of complete air conditioning systems –	1

	humidifiers and dehumidifiers –	1
	cooling load calculations,	2
	types of air conditioners – applications	1
	Total	**32**

Practicals

S.No	Topic	No. of Practical's
1	Tutorials onthermodynamic aircycles	**1**
2	StudyandapplicationofPVandTSchartinrefrigeration,PHchart(or) Mollierdiagramin refrigeration	**1**
3	Numericalon airrefrigeration cycle systems	**1**
4	Numericalon vapourcompressioncyclerefrigeration system	**1**
5	Studyofdomestic watercooler	**1**
6	Studyofdomestic household refrigerator	**1**
7	Studyofabsorption type solarrefrigerationsystem	**1**
8	Studycoldstorageforfruitandvegetables,Freezingloadandtimecalculations forfood materials	**2**
9	Determination ofrefrigeration parametersusingrefrigerationtutor– II	**1**
10	Numericalon design ofair conditioningsystems	**1**
11	Studyofwindowairconditioner	**1**
12	Studyon repairand maintenanceofrefrigeration and air-conditioningsystems	**2**
13	Visit tochillingoricemakingand coldstorage plants	**2**
	Total	**16**

Suggested Readings

Kothandaraman C P Khajuria P Rand Arora S C. 1992. A CourseinThermodynamicsand HeatEngines. Dhanpet Raiand Sons, 1682 NaiSarak, New Delhi.

KhurmiRS. 1992. EngineeringThermodynamics. S Chand and Co. Ltd., RamNagar, New Delhi.

MathurM L andMehta FS. 1992.Thermodynamicsand HeatPowerEngineering. DhanpatRaiand Sons 1682 NaiSarak, New Delhi.

BallneyP. L. 1994.ThermalEngineering.Khanna Publishers, New Delhi.

NagP K.1995. EngineeringThermodynamics.Tata McGraw HillPublishingCo.Ltd., 12/4AsafAliRaod, New Delhi.

Sr. No.	CourseName	CourseNo.	Credit	L	P	T
9	ElectricalMachines andPower Utilization	EE-2.3.9	3(2 +1)	2	1	0

Coursecontent:

Theory

BASIC CONCEPTS: Basic electrical quantities – specific resistance – temperature coefficient.DCCIRCUITS: Kirchhoff's laws –Thevenin, Superpositiontheorem– stardelta transformation.MAGNETIC CIRCUITS**:**Electromotive force, reluctance,lawsofmagneticcircuits,determinationof ampere-turns for series and parallel magnetic circuits, hysteresis and eddy current losses. DCMACHINES:DCGenerators:Principles,operationandperformanceofDC machine(generatorand motor),EMFandtorqueequations,armaturereaction,commutation, excitationofDCgeneratorand their characteristics;DCMotors:DCmotorcharacteristics, starting ofshuntandseriesmotor, starters,speed controlmethods-fieldand armature control. AC CIRCUITS:SinglephaseAC circuits:Basics– RMSandaveragequantities.ThreephaseAC circuits:Reasonsforuseofthreephasesystems– staranddeltaforgenerationandload- powerfactor- power and energy measurement various methods of three phase power measurement; power factor, reactiveandapparentpower,Conceptandanalysisofbalanced poly-phasecircuits;Seriesandparallel resonance;ACMACHINES:Transformer:Principleofworking,constructionof singlephase transformer, EMF equation, phasor diagram on load, leakage reactance, voltage regulation, power and energy efficiency, open circuitandshortcircuit tests;Poly-phase induction motor:Construction, operation, phasor diagram,effectof rotorresistance, torque equation, starting andspeed controlmethods.Single-phase inductionmotor:Doublefieldrevolving theory,equivalentcircuit,characteristics,phasesplit,shadedpole motors

Practicals

ToobtainloadcharacteristicsofD.C.shunt/series/compoundgenerator; TostudycharacteristicsofDC shunt/seriesmotors;Tostudyd.c.motorstarters;ToPerform load-teston3ph.inductionmotor&toplot torqueV/Sspeedcharacteristics;Toperformno-load&blocked–rotortestson 3ph.Inductionmotorto obtainequivalentckt.parameters& todrawcirclediagram;Tostudy thespeedcontrolof3ph.induction motorby cascading of two inductionmotors,i.e.by feeding theslippowerof onemotorintotheother motor;Tostudystar-deltastartersphysicallyand(a)todrawelectricalconnectiondiagram(b)tostartthe 3ph.inductionmotorusing it.(c)toreversethedirectionof3ph.I.M.;Tostarta3-phaseslip–ring inductionmotorby inserting different levels of resistance in the rotor ckt.andtoplottorque–speed characteristics; Toperform noload&blocked–rotorteston1ph.inductionmotor&todeterminethe parameters ofequivalentckt. drawn on thebasis ofdouble revolvingfieldtheory;To performload–teston 1ph.inductionmotor&plottorque–speedcharacteristics;Tostudy powerconsumedinathree-phase

S. No.	Topicsto becoveredin Lecture	Proposed No. of Lectures
1	Basicelectricalquantities, specific resistance,electricalunits,Temperature coefficient	1
2	DCcircuits,Kirchoff'sfirstlaw	1
3	Kirchoff'ssecond law , problemon this law	1
4	Theveninstheorem, superpositiontheorem, problemsolving	2
5	Stardeltatransformation	1
6	Electro motive force, reluctance,laws ofmagnetic circuits,	1
7	Determination ofampere-turnsforseries and parallel magneticcircuits	1
8	Hysteresis and eddycurrentlosses	1
9	Principles,operationand performance ofDCgenerator	1
10	EMF, armature reaction, commutation	1
11	Excitation ofDCgeneratorand theircharacteristics	2
12	DCmotorcharacteristics	1
13	Startingofshuntand seriesmotor, starters	1

14	Speed controlmethods-field and armaturecontrol	1
15	Basics– RMSand average quantities	1
16	Threephase ACcircuits– reasons foruse ofthreephase systems– starand delta forgenerationandload	1
17	Powerfactor,reactive andapparentpower	1
18	Powerand energy measurementvarious methodsofthreephasepower measurement	2
19	Conceptandanalysis ofbalancedpoly-phase circuits	1
20	Seriesand parallelresonance	2
21	Principle ofworking, constructionofsingle phase transformer	1
22	EMF equation, phasordiagramon load,leakage reactance	1
23	Voltage regulation,powerand energyefficiency	1
24	Open circuitand shortcircuittests	1
25	Construction,operation,phasordiagram	1
26	Effectofrotorresistance,torqueequation, startingandspeedcontrolmethods	1
27	Doublefieldrevolvingtheory equivalentcircuit	1
28	Characteristics,phase split,shaded pole motors	1
	Total	**32**

Practicals

S.No	**Topic**	**No. of Practicals**
1	To obtainloadcharacteristicsofd.c.shunt/series/compound generator;	**3**
2	TostudycharacteristicsofDCshunt/seriesmotors	**2**
3	Tostudyd.c. motorstarters	**1**
4	To Performload-teston 3 ph. induction motor&to plot torqueV/S speed characteristics	**1**
5	To performno-load & blocked–rotortests on 3ph. Induction motorto obtain equivalentckt. parameters&to drawcircle diagram	**1**
6	Tostudythe speed controlof3 ph.induction motorbycascadingof two induction motors,i.e.byfeedingtheslip powerofone motor intotheother motor	**1**
7	Tostudy star-delta startersphysicallyand (a)to draw electricalconnection diagram(b)to startthe 3 ph. induction motorusingit. (c)to reversethe direction of3 ph. I.M	**1**
8	Tostarta 3-phase slip–ringinduction motorbyinsertingdifferentlevels of resistanceintherotorckt. and to plot torque–speed characteristics	**1**
9	To performno load &blocked–rotorteston 1 ph. induction motor& to determinethe parameters ofequivalentckt. drawn onthe basis ofdouble revolvingfield theory	**1**
10	To performload–teston 1ph. induction motor&plottorque–speed characteristics	**1**
11	Tostudypowerconsumed in a three-phasecircuit	**1**
12	Twolightsin seriescontrolled byone switch	**1**
13	Twolightsin parallelcontrolled byone switch.	**1**
	Total	**16**

Suggested Readings

Thareja B L&Theraja AK.2005. A textbookofElectricalTechnology. Vol. IS. Chand &CompanyLTD., New Delhi.
Theraja B L&TherajaAK2005. A textbookofElectricalTechnology. Vol. IIS.Chand &CompanyLTD., New Delhi.
VincentDelToro.2000. ElectricalEngineeringFundamentals. Prentice-HallofIndia PrivateLTD., NewDelhi.
Anwani ML. 1997. BasicElectricalEngineering. DhanpatRai& Co.(P)LTD. New Delhi

Sr. No.	CourseName	CourseNo.	Credit	L	P	T
10	NSS/NCC/Physical Education	Phy. Edu. – 2.3.10	0(0 +1)	0	0	0

SEMESTER – IV

Sr. No.	CourseName	CourseNo.	Credit	L	P	T
1	**Building Constructionand Cost Estimation**	**CE-2.4.1**	**2(2 +0)**	**2**	**0**	**0**

Coursecontent:

Theory:

BuildingMaterials:Rocks,Stones,BricksPropertiesandvarietiesofTiles,Lime,Cement,Concrete, Sand.Glass,Rubber,Plastics,iron,Steel,Aluminium,Copper,Nickle. Timber.Buildingcomponents: Lintels,Arches,staircases,Differenttypesoffloors,Finishing:DampProofing andwaterproofing, Plastering,pointing,whitewashinganddistempering–Painting,Buildingdesign,Designprocedures, Technology, buildingconstruction,Typesofagriculturalbuildingsandrelatedneeds,applicationof designtheoryandpracticetotheconservation,slopedandflatroofbuildings,construction economics: Preliminary estimates,DetailedEstimatesofBuildingssourceofcostinformation, useofcostanalyses for controlling design,Factorsaffecting building costs;costevaluationofdesignandplanning alternativesfor building andestatedevelopment,Measurementandpricing,Economicmethodsforevaluating investments inbuildingsandbuilding systems:cost-in-use,benefit-to-costsandsavings-to-investmentratios,rateof return, netbenefits, payback

Planningof lectures

S. No.	Topicsto becoveredin Lecture	Proposed No. of Lectures
1	BuildingMaterials:Rocks,Stones, Bricks	2
2	Propertiesand varieties ofTiles, Lime, Cement, Concrete, Sand. Glass,Rubber, Plastics,iron,Steel, Aluminium, Copper, Nickle.Timber.	3
3	Buildingcomponents:Lintels, Arches, staircases,	3
4	Differenttypesoffloors,	2
5	Finishing:Damp Proofingand waterproofing, Plastering, pointing,	3
6	white washingand distempering – Painting,	2
7	Buildingdesign, Designprocedures,Technology	2
8	buildingconstruction,Types ofagriculturalbuildings and related needs,	2
9	application ofdesign theoryand practiceto the conservation, sloped andflatroof buildings	3
10	constructioneconomics:Preliminaryestimates,	1
11	DetailedEstimatesofBuildings sourceofcostinformation, useofcostanalyses forcontrollingdesign,	3
12	Factorsaffectingbuildingcosts;costevaluation ofdesign and planning alternatives forbuildingand estate development,	3
13	Measurementand pricing, Economic methods forevaluatinginvestmentsin buildings andbuildingsystems:cost-in-use, benefit-to-costs and savings-to-investmentratios,rate of return,netbenefits,payback	3
	Total	**32**

Suggested Readings

PunmiaB.C. AshokKumarJainand ArunKumarJain.BuildingConstruction. LaxmiPublications(P)ltd., New Delhi.

DuggalS K. Buildingmaterial. New Age InternationalPublishers.

Sane Y.S. Planningand DesigningofBuildings.

Rangwala S C. 1994. EngineeringMaterials. CharotarPublishingHouse, Anand.

Dutta B.N. 2000. Estimatingand Costing. UBS publishers.

Sr. No.	CourseName	CourseNo.	Credit	L	P	T
2	**Auto CADApplications**	**ME-2.4.2**	**2(0 + 2)**	**0**	**2**	**0**

Course content:

Practical

Applicationofcomputersfordesign.CAD-OverviewofCADwindow–Explanationofvarious options ondrawing screen. Study of draw and dimension tool bar. Practice ondraw and dimensiontoolbar.StudyofOSNAP,linethicknessandformattoolbar.PracticeonOSNAP, linethicknessandformattoolbar.Practiceonmirror,offsetandarraycommands.Practiceon trim,extend,chamfer andfilletcommands. Practice oncopy,move,scaleandrotatecommands. Drawing of2D-drawing using drawtoolbar.Practiceoncreating boundary,region,hatchand gradientcommands.PracticeonEditingpolyline-PEDITandExplodecommands.Settingof viewportsforsketcheddrawings.Printing ofselectedviewportsinvariouspapersizes.2D- drawingofmachinepartswithalldimensionsandallowances-Footstepbearingandknuckle joint.Sectioning offootstepbearingandstuffingbox.Drawing ofhexagonal,nutandboltand other machineparts. Practice on3-Dcommands-Extrusionandloft.Practice on3-Dcommands- onsweepandpresspull.Practiceon3-DCommands-revolving andjoining.Demonstrationon CNC machine and simpleproblems.

Practicals

S.No.	Topic	No.of practical'
1	Introduction ofCADand useofcomputers fordesign	2
2	CAD-Overview of CAD window. Explanationofvarious options screen	2
3	Studyofdraw anddimension toolbar	2
4	Practice on draw and dimensiontoolbar	2
5	StudyofOSNAP, linethickness andformattoolbar	2
6	Practice on OSNAP, linethicknessand format toolbar	2
7	Practice on mirror,offsetand arraycommands	2
8	Practice ontrim, extend,chamferandfilletcommands	2
9	Practice oncopy, move, scale and rotate commands	2
10	Drawingof2 D-drawingusingdrawtoolbar	2
11	Practice oncreatingboundary, region, hatchand gradientcommands	2
12	Practice on Editingpolyline-PEDITand Explodecommands	2
13	2D-drawingofmachineparts withalldimensionsandallowances	2
14	Drawingofhexagonal,nutand boltand othermachineparts	2
15	Practice on 3-DcommandsusingAuto CAD, Pro-E and Bob CAD	2
16	Demonstration on CNCmachine	2
	Total	32

SuggestedReadings

Rao P.N.. 2002. CAD/CAM Principles andApplications. McGraw-HillEducation Pvt.Ltd., New Delhi.

Sareen Kuldeep and Chandan DeepGrewal. 2010. CAD/CAM TheoryandPractice. S.Chand& Company Ltd., New Delhi.

ZeidIbrahim. 2011. MasteringCAD/CAM with Engineering. McGraw-HillEducation Pvt.Ltd., New Delhi.

LeeKunwoo. 1999. Principles of CAD/CAM/CAE Systems. Addison Vesley Longman,Inc.

Sr. No.	CourseName	CourseNo.	Credit	L	P	T
3	**Applied Electronicsand Instrumentation**	**EE-2.4.3**	**3(2 +1)**	**2**	**1**	**0**

Coursecontent:

Theory

Semiconductors.p—njunction.V—Icharacteristicsofp—njunction.diodeasacircuitelement.rectifier. clipper.damper,voltagemultiplier,capacitivefilter.diodecircuitsforOR&AND(bothpositiveand negativelogic),bipolar junctiontransistor:operating point.classification(A.B&C)ofamplifier.various biasing methods(fixed. selfpotentialdivider).h-parametermodelofatransistor.analysisofsmallsignal. CEamplifier.phaseshiftoscillator,analysisofdifferentialamplifierusing transistor.IdealOP-AMP characteristics. linear and non-linear applications of OP-AMP (adder. subtractor. integrator, active rectifier. comparator. differentiator. differential, instrumentation amplifierand oscillator). zenerdiode voltageregulator.transistorseriesregulator.currentlimiting.OP-AMPvoltageregulators.Basictheorem ofBooleanalgebra.Combinationallogiccircuits(basicgates.SOPruleandKmap).binaryladderD/A converter,successiveapproximationA/D converter,generalizedinstrumentation,measurementof displacement.temperature. velocity,forceandpressureusing potentiometer. resistancethennometer. thermocouples. Bourclentube. LVDT.straingauge andtacho-generator.

Practical

Tostudy V-I characteristicsofp-njunctiondiode:Tostudyhalfwave.fullwaveandbridgerectifier:To study transistorcharacteristicsinCEconfigurations:Todesignandstudy fixedandselfbias transistor:To designandstudypotentialdividerbiastransistor:Tostudyadiodeasclipperand clamper:TostudyaOP-AMPIC741asinvertingandnon- invertingamplifier: TostudyaOP-AMPIC741asdifferentiatorand integratortostudyadifferentialamplifierusingtwotransistor:TostudyaOP-AMPIC741asdifferential amplifier:Tostudyazenerregulatorcircuit:TostudyaOP-AMPIC741asaactiverectifier:Tostudya OP-AMPIC741 asa comparator:Tofamiliarize with varioustypesoftransducers.

Planningof lectures

S. No.	Topicsto becoveredin Lecture	Proposed No. of Lectures
1	Semiconductors, P-Njunction, V-IcharacteristicsofP-Njunction	2
2	Diode as acircuitelement,rectifier	2
3	Clipper, clamper	2
4	Voltage multiplier,Capacitive filter	2
5	Diode circuitsforOR&ANDgate	1
6	BipolarjunctionTransistor;operatingpoint	2
7	Classification ofamplifier, various biasingmethods	2
8	h-parametermodelofatransistor,analysis ofsmallsignal	2
9	CE amplifier, phaseshiftoscillator	2
10	Analysis ofdifferentamplifierusingtransistor	2
11	IdealOP-AMP characteristics	1
12	Linearand Non-linearapplication ofOP-AMP	2
13	ZenerdiodeVoltage Regulator, transistorseries regulator	2
14	Currentlimiting, OP-AMP Voltage regulator	1
15	BasictheoremofBoolean algebra, Combinationallogic circuits	1
16	BinaryladderD/Aconverter,Successive approximation A/Dconverter	1
17	Generalizedinstrumentation, measurementofdisplacement, temperature using potentiometer	1
18	Velocity, force and pressure measurementusingpotentiometer	1
19	Resistance thermometer, thermocouple	1
20	Bourden tube, LVDT	1

21	Strain gauge and tacho generator	1
	Total	**32**

Practicals

S.No.	Topic	No. of Praticals
1	TostudyV-Icharacteristicsofp-n junctiondiode	1
2	Tostudyhalfwave. fullwave and bridge rectifier	1
3	Tostudya diodeasclipperand clamper	2
4	Tostudytransistorcharacteristicsin CE configurations	1
5	To design and studyfixed and self-biastransistor	1
6	To design and studypotentialdividerbias transistor	1
7	Tostudya OP-AMPIC741 asinvertingand non-invertingamplifier	2
8	Tostudya OP-AMPIC741 asdifferentiatorandintegratorto studya differential amplifierusingtwotransistor	2
9	Tostudya OP-AMPIC741 asdifferentialamplifier	1
10	Tostudya zener regulatorcircuit	1
11	Tostudya OP-AMPIC741 asaactive rectifier	1
12	Tostudya OP-AMPIC741 asacomparator	1
13	Tofamiliarize with varioustypesoftransducers	1
	Total	**16**

Suggested Readings

RobertL Boyelsted, Electronic Devicesand CircuitTheory

MehtaVK. PrinciplesofElectronics. S. Chand and Co., New Delhi.

ShaneyAK.MeasurementofElectronicsand Electronic Instrumentation. KhannaPublications.

RoyChowdary.IntegratedElectronics. John Wiley International.

KumarAnand. DigitalElectronics. A. PHI.

Gupta Sanjeev, Sonthosh Gupta. Electronic Devicesand Circuits. Danapath RaiPublications

Sr. No.	CourseName	CourseNo.	Credit	L	P	T
4	**Tractor and Automotive Engines**	**FMPE-2.4.4**	**3 (2 + 1)**	**2**	**1**	**0**

Coursecontent: Theory

Study of sources of farm power –conventional & non-conventional energy sources. Classification of tractors and IC engines. Review of thermodynamic principles of IC (CI & SI) engines and deviation from ideal cycle. General energy equation and heat balance sheet. Study of mechanical, thermal and volumetric efficiencies. Study of engine components their construction, operating principles and functions. Study of engine strokes and comparison of 2-stroke and 4-stroke engine cycles and CI and SI engines. Study of Engine Valve systems, valve mechanism, Valve timing diagram, and valve clearance adjustment Study of Cam profile, valve lift and valve opening area. Study of importance of air cleaning system. Study of types of air cleaners and performance characteristics of various air cleaners. Study of fuel supply system. Study of fuels, properties of fuels, calculation of air-fuel ratio. Study of tests on fuel for SI and CI engines. Study of detonation and knocking in IC engines. Study of carburetion system, carburetors and their main functional components. Study of fuel injection system – Injection pump, their types, working principles. Fuel injector nozzles – their types and working principle. Engine governing – need of governors, governor types and governor characteristics. Study of lubrication system – need, types, functional components. Study of lubricants – physical properties, additives and their application. Engine cooling system – need, cooling methods and main functional components. Study of need and type of thermostat valves. Additives in the coolant. Study of radiator efficiency. Study of ignition system of SI engines. Study of electrical system including battery, starting motor, battery charging, cut-out, etc. Comparison of dynamo and alternator. Familiarization with the basics of engine testing

Practical

Introduction to different systems of CI engines; Engine parts and functions, working principles etc. Valve system – study, construction and adjustments; Oil & Fuel – determination of physical properties; Air cleaning system; Fuel supply system of SI engine; Diesel injection system & timing; Cooling system, and fan performance, thermostat and radiator performance evaluation; Part load efficiencies & governing; Lubricating system & adjustments; Starting and electrical system; Ignition system; Tractor engine heat balance and engine performance curves; Visit to engine manufacturer/ assembler/ spare parts agency.

Planningof lectures

S. No.	Topicsto becoveredin Lecture	Proposed No. of Lectures
1.	Study of sources of farm power –conventional & non-conventional energy sources.	2
2.	Classification of tractors and IC engines.	2
3.	Review of thermodynamic principles of IC (CI & SI) engines and deviation from	2
4.	General energy equation and heat balance sheet.	2
5.	Study of mechanical, thermal and volumetric efficiencies.	2
6.	Study of engine components their construction, operating principles and functions.	2
7.	Study of engine strokes and comparison of 2-stroke and 4-stroke engine cycles and	2
8.	Study of Engine Valve systems, valve mechanism, Valve timing diagram, and valve	2
9.	Study of importance of air cleaning system. Study of types of air cleaners and	2
10.	Study of fuel supply system. Study of fuels, properties of fuels, calculation of air-	2
11.	Study of tests on fuel for SI and CI engines. Study of detonation and knocking in IC	2
12.	Study of carburetion system, carburetors and their main functional components.	2
13.	Engine governing – need of governors, governor types and governor characteristics.	2
14.	Study of lubrication system – need, types, functional components. Study of	2
15.	Engine cooling system – need, cooling methods and main functional components.	2
16.	Study of ignition system of SI engines. Study of electrical system including battery,	2
17.	Familiarization with the basics of engine testing	2
	Total	**34**

Practicals		
S.No.	**Topic**	**No. of Praticals**
1.	Introduction to different systems of CI engines; Engine parts and functions, working	2
2.	Valve system – study, construction and adjustments	1
3.	Oil & Fuel – determination of physical properties	1
4.	Air cleaning system	1
5.	Fuel supply system of SI and CI engine	2
6.	Diesel injection system & timing	1
7.	Cooling system, and fan performance, thermostat and radiator performance evaluation	1
8.	Part load efficiencies & governing	1
9.	Lubricating system & adjustments	1
10.	Starting and electrical system	1
11.	Ignition system	1
12.	Tractor engine heat balance and engine performance curves	1
13.	Visit to engine manufacturer/ assembler/ spare parts agency	1
	Total	**15**

Suggested Readings

Liljedahl J B and Others. Tractors and Their Power Units.
Rodichev V and G Rodicheva. Tractors and Automobiles.
Mathur ML and RP Sharma. A course in Internal Combustion Engines.
Singh Kirpal. Automobile Engineering – Vol II.
Heitner Joseph. Automotive Mechanics : Principles and Practices.

Sr. No.	CourseName	CourseNo.	Credit	L	P	T
5.	Engineering properties of Agricultural	PFE-2.4.5	2 (1 + 1)	1	1	0

Course content :

Theory

Classification and importance of engineering properties of Agricultural Produce, shape, size, roundness, sphericity, volume, density, porosity, specific gravity, surface area of grains, fruits and vegetables, Thermal properties, Heat capacity, Specific heat, Thermal conductivity, Thermal diffusivity, Heat of respiration; Co-efficient of thermal expansion, Friction in agricultural materials; Static friction, Kinetic friction, rolling resistance, angle of internal friction, angle of repose, Flow of bulk granular materials, Aero dynamics of agricultural products, drag coefficients, terminal velocity. Rheological properties; force, deformation, stress, strain, elastic, plastic and viscous behaviour, Newtonian and Non-Newtonian liquid, Visco-elasticity, Newtonian and Non-Newtonian fluid, Pseudo-plastic, Dilatant, Thixotropic, Rheopectic and Bingham Plastic Foods, Flow curves. Electrical properties; dielectric loss factor, loss tangent, A.C. conductivity and dielectric constant, method of determination. Application of engineering properties in handling processing machines and storage structure

Practical

Determination of the shape and size of grains, fruits and vegetables, Determination of bulk density and angle of repose of grains, Determination of the particle density/true density and porosity of solid grains, Finding the co-efficient of external and internal friction of different crops, Finding out the terminal velocity of grain sample and study the separating behaviour in a vertical wind tunnel, Finding the thermal conductivity of different grains, Determination of specific heat of some food grains, Determination of hardness of food material and determination of viscosity of liquid foods.

S. No.	Topics to be covered in Lecture	Proposed No. of Lectures
1	Classification and importance of engineering properties of Agricultural Produce	1
2	Shape, size, roundness, sphericity, volume	1
3	Density, porosity, specific gravity, surface area of grains, fruits and vegetables	1
4	Thermal properties, Heat capacity, Specific heat, Thermal conductivity	1
5	Thermal diffusivity, Heat of respiration, Co-efficient of thermal expansion	1
6	Friction in agricultural materials; Static friction, Kinetic friction	1
7	Rolling resistance, angle of internal friction, angle of repose, Flow of bulk granular materials	2
8	Aero dynamics of agricultural products, drag coefficients, terminal velocity	1
9	Rheological properties; force, deformation, stress, strain, elastic, plastic and viscous behaviour	2
10	Newtonian and Non-Newtonian liquid, Visco-elasticity, Newtonian and Non-Newtonian fluid	1
11	Pseudo-plastic, Dilatant, Thixotropic, Rheopectic and Bingham Plastic Foods, Flow curves	1
12	Electrical properties; dielectric loss factor, loss tangent	1
13	A.C. conductivity and dielectric constant, method of determination	1
14	Application of engineering properties in handling processing machines and storage structures	1
	Total	**16**

Practical

S.No.	1. Topic	No. of Practical
1	Determination of shape and size grains using micrometer.	1
2	Determination of shape and size of fruits and vegetables using vernier caliper	1

3	Determination of sphericity, roundness and roundness ratio of grains	1
4	Determination of sphericity, roundness and roundness ratio of fruits and vegetables	1
5	Determination of bulk density of grains	1
6	Determination of particle density/true density and porosity of solid grains.	1
7	Determination of porosity of solid grains.	1
8	Determination of angle of repose for grains	1
9	Determination co-efficient of external friction of grain	1
10	Determination co-efficient of internal friction of grain	1
11	Determination of hardness of food material.	1
12	Determination of thermal conductivity of grains	1
13	Determination of specific heat of grains	1
14	Preparation of a ready re-ckoner of change in unit weight of food grains as affected by change in its moisture content (w.b.) (5% - 25%).	1
15	Determination of viscosity of liquid foods	1
16	Finding out the terminal velocity of grain samples and study the separating behaviour in a vertical wind tunnel	1
	Total	**16**

Suggested Readings

ohesin, N.N. 1980. Physical Properties of Plants & Animals. Gordon & Breach Science Publishers , New York.

ohesin, N.N. 1980. Thermal Properties of Foods and Agricultural Materials. Gordon & Breach Science Publishers , New York.

rentice, J.H. 1984. Measurement in Rheological Properties of Food Stuffs. Elsevier Applied science Pub. Co. Inc. New York.

Rao, M.A. and Rizvi, S.H., 1995. Engineering Properties of Foods. Marcel Dekker Inc. New York.

Singhal OP & Samuel DVK. 2003. Engineering Properties of Biological Materials. Saroj Prakashan.

Sr. No.	Course Name	Course No.	Credit	L	P	T
6	Watershed Hydrology	SWCE-2.4.6	1 (1 + 1)	1	1	0

Course content :

Theory:

Hydrologic cycle, precipitation and its forms, rainfall measurement and estimation of mean rainfall, 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. Stream gauging - discharge rating curves, flood peak, design flood and computation of probable flood. Flood routing – channel and reservoir routing. Drought – classification, causes and impacts, drought management strategy.

Practical:

Visit to meteorological observatory and study of different instruments. Design of rain gauge network. Exercise on intensity - frequency - duration curves. Exercise on depth - area - duration and double mass curves. Analysis of rainfall data and estimation of mean rainfall by different methods. Exercise on frequency analysis of hydrologic data and estimation of missing data, test for consistency of rainfall records. Exercise on 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. Exercise on geomorphic parameters of watersheds. Exercise on runoff hydrograph. Exercise on unit hydrograph. Exercise on synthetic hydrograph. Exercise on flood routing.

Planning of lectures

S. No.	Topics to be covered in Lecture	Proposed No. of Lectures
1.	Hydrologic cycle, precipitation and its forms	1
2.	rainfall measurement and estimation of mean rainfall	1
3.	frequency analysis of point rainfall	1
4.	Mass curve, hyetograph, depth-area-duration curves and intensity-duration-frequency relationship	1
5.	Hydrologic processes-Interception, infiltration -factors influencing, measurement and indices	1
6.	Evaporation - Estimation and measurement	1
7.	Runoff - Factors affecting, measurement, stage - discharge rating curve,	1
8.	estimation of peak runoff rate and volume	1
9.	Rational method, Cook's method and SCS curve number method	1
10.	Geomorphology of watersheds – Linear, aerial and relief aspects of watersheds-stream order, drainage density and stream frequency	1
11.	Hydrograph - Components, base flow separation, unit hydrograph theory	1
12.	S-curve, synthetic hydrograph, applications and limitations	1
13.	Stream gauging - discharge rating curves, flood peak, design flood and computation of probable flood	1
14.	Flood routing – channel and reservoir routing	1
15.	Drought – classification, causes and impacts	1
16.	drought management strategy	1
Total		**16**

Practicals

S.No.	2. Topic	No. of Practicals
1	Visit to meteorological observatory and study of different instruments.	1
2	Design of rain gauge network.	1

3	Exercise on intensity - frequency - duration curves.	1
4	Exercise on depth - area - duration and double mass curves.	2
5	Analysis of rainfall data and estimation of mean rainfall by different methods.	1
6	Exercise on frequency analysis of hydrologic data and estimation of missing data, test for consistency of rainfall records.	2
7	Exercise on computation of infiltration indices.	1
8	Computation of peak runoff and runoff volume by Cook's method and rational formula.	1
9	Computation of runoff volume by SCS curve number method.	1
10	Study of stream gauging instruments - current meter and stage level recorder.	1
11	Exercise on geomorphic parameters of watersheds.	1
12	Exercise on runoff hydrograph.	1
13	Exercise on unit hydrograph.	2
14	Exercise on synthetic hydrograph.	1
	Total	**16**

Suggested Readings

Chow, V.T., D.R. Maidment and L.W. Mays. 2010. Applied Hydrology, McGraw Hill Publishing Co., New York.

Jaya Rami Reddy, P. 2011. A Text Book of Hydrology. University Science Press, New Delhi.

Linsley, R.K., M.A. Kohler, and J.L.H. Paulhus. 1984. Hydrology for Engineers. McGraw-Hill Publishing Co., Japan.

Mutreja, K.N. 1990. Applied Hydrology. Tata McGraw-Hill Publishing Co., New Delhi.

Raghunath, H.M. 2006. Hydrology: Principles Analysis and Design. Revised 2nd Edition, New Age International (P) Limited Publishers, New Delhi.

Subramanya, K. 2008. Engineering Hydrology. 3rd Edition, Tata McGraw-Hill Publishing Co., New Delhi.

Suresh, R. 2005. Watershed Hydrology. Standard Publishers Distributors, Delhi.

Varshney, R.S. 1986. Engineering Hydrology. Nem Chand and Brothers, Roorkee, U.P.

Sr. No	Course Name	Course No.	Credit	L	P	T
7	**Irrigation Engineering**	**IDE-2.4.7**	**3(2+1)**	**2**	**1**	**0**

Course Content:

Theory: Major and medium irrigation schemes of India, purpose of irrigation, environmental impact of irrigation projects, 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; open channel water conveyance system : 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 levelling, land levelling design methods, estimation of earth work; 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.

Practical: Measurement of soil moisture by different soil moisture measuring instruments; measurement of irrigation water; measurement of infiltration characteristics; determination of bulk density, field capacity and wilting point; estimation of evapotranspiration; land grading methods; design of underground pipeline system; estimation of irrigation efficiency; study of advance, recession and computation of infiltration opportunity time; infiltration by inflow-outflow method; evaluation of border irrigation method; evaluation of furrow irrigation method; evaluation of check basin irrigation method.

Planning of Lecture

Sr. No	Topics to be covered in Lecture	Proposed No. of Lectures
1.	Major and medium irrigation schemes of India, purpose of irrigation, environmental impact of irrigation projects, source of irrigation water, present status of development and utilization of different water resources of the country	6
2.	Measurement of irrigation water: weir, flumes and orifices and other methods	4
3.	open channel water conveyance system : design and lining of irrigation field channels, on farm structures for water conveyance, control & distribution; underground pipe conveyance system: components and design	6
4.	land grading: criteria for land levelling, land levelling design methods, estimation of earth work.	4
5.	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.	6
6.	surface methods of water application: border, check basin and furrow irrigation-adaptability, specification and design considerations	6
	Total	**32**

Practical

S. No	Topics	No. of Practical
1.	Measurement of soil moisture by different soil moisture measuring instruments	2
2.	Measurement of irrigation water	2
3.	Measurement of infiltration characteristics	1
4.	Determination of bulk density, field capacity and wilting point	2
5.	Estimation of evapotranspiration	1
6.	Land grading methods	1

7.	Design of underground pipeline system	1
8.	Estimation of irrigation efficiency	1
9.	Study of advance, recession and computation of infiltration opportunity time	1
10.	Infiltration by inflow-outflow method	1
11.	Evaluation of border irrigation method	1
12.	Evaluation of furrow irrigation method	1
13.	Evaluation of check basin irrigation method.	1
Total		**16**

Suggested Readings

Michael A.M. 2012. Irrigation: Theory and Practice. Vikas Publishing House New Delhi.

Majumdar D. K. 2013. Irrigation Water Management Principles. PHI learning Private Limited New Delhi 2nd Edition.

Allen R. G., L. S. Pereira, D. Raes, M. Smith. 1998. Crop Evapotranspiration guidelines for computing crop water requirement. Irrigation and drainage Paper 56, FAO of United Nations, Rome.

Murthy VVN. 2013. Land and Water Management Engineering. Kalyani Publishers, New Delhi.

Israelsen O W. and Hansen V. E and Stringham G. E. 1980. Irrigation Principles and Practice, John Wiley & Sons, Inc. USA.

Sr. No	Course Name	Course No.	Credit	L	P	T
8	**Sprinkler and Micro irrigation Systems**	**IDE-2.4.8**	**2(1+1)**	**1**	**1**	**0**

Course Content:

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: 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 patters, 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, fertilizers solubility and their compatibility, precautions for successful fertigation system, fertigation frequency, duration and injection rate, methods of fertigation.

Practical: Study of different components of sprinkler irrigation system; design and installation of sprinkler irrigation system; determination of precipitation pattern, discharge and uniformity coefficient; cost economics of sprinkler irrigation system; 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; determination of rate of injection and calibration for chemigation/fertigation; design of irrigation and fertigation schedule for crops; field visit to micro irrigation system and evaluation of drip system; cost economics of drip irrigation system.

Planning of Lecture

Sr. No	Topics to be covered in Lecture	Proposed No. of Lecture
1.	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: uniformity coefficient and pattern efficiency;	3
2.	Micro Irrigation Systems: types-drip, spray, & bubbler systems, merits and demerits, different components;	3
3.	Design of drip irrigation system: general considerations, wetting patters, irrigation requirement, emitter selection, hydraulics of drip irrigation system, design steps;	4
4.	Necessary steps for proper operation of a drip irrigation system; maintenance of micro irrigation system: clogging problems, filter cleaning, flushing and chemical treatment	3
5.	Fertigation: advantages and limitations of fertigation, fertilizers solubility and their compatibility, precautions for successful fertigation system, fertigation frequency, duration and injection rate, methods of fertigation.	3
	Total	**16**

Practical

Sr. No	Topics	No. of Practical
1.	Study of different components of sprinkler irrigation system	1
2.	Design and installation of sprinkler irrigation system	2
3.	Determination of precipitation pattern, discharge and uniformity coefficient	2
4.	Cost economics of sprinkler irrigation system	1
5.	Study of different components of drip irrigation	2
6.	Design and installation of drip irrigation system	2
7.	Determination of pressure discharge relationship and emission uniformity for given emitter	1
8.	Study of different types of filters and determination of filtration efficiency	1
9.	Determination of rate of injection and calibration for chemigation/fertigation	1
10.	Design of irrigation and fertigation schedule for crops	1

11.	Field visit to micro irrigation system and evaluation of drip system	1
12.	Cost economics of drip irrigation system.	1
	Total	**16**

Suggested Readings

Keller Jack and Bliesner Ron D. 2001. Sprinkle and Trickle Irrigation. Springer Science+ business Media, New York .

Mane M.S. and Ayare B.L.2007. Principles of Sprinkler Irrigation systems, Jain Brothers, New Delhi.

Mane M.S and Ayare B.L. and MagarS.S.2006.Principles of Drip Irrigation systems, Jain Brothers, New Delhi.

Michael AM, Shrimohan and KR Swaminathan. Design and evaluation of irrigation methods, (IARI Monograph No.1). Water Technology Centre, IARI New Delhi.

Michael A.M. 2012. Irrigation: Theory and Practice. Vikas Publishing Vikas Pub. House New Delhi.

Choudhary M.L and Kadam U.S 2006. Micro irrigation for cash crops Westville Publishing

Sr. No.	Course Name	Course No.	Credit	L	P	T
9	**Fundamentals of Renewable Energy Sources**	**REE-2.4.9**	**3 (2+1)**	**2**	**1**	**0**

Course Content:

Theory:

Concept and limitation of Renewable Energy Sources (RES), Criteria for assessing the potential of RES, Classification of RES, Solar, Wind, Geothermal, Biomass, Ocean energy sources, 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 drying system, Solar Photo voltaics: 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 available from wind, General formula, Lift and drag. Basis 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. Bio-energy: Pyrolysis of Biomass to produce solid, liquid and gaseous fuels. Biomass gasification, Types of gasifier, various types of biomass cook stoves for rural energy needs. Biogas: types of biogas plants, biogas generation, factors affecting biogas generation and usages, design consideration, advantages and disadvantages of biogas spent slurry.

Practical

Study of different types of solar cookers, solar water heating system, natural convection solar dryer, forced convection solar dryer, solar desalination unit, solar greenhouse for agriculture production, biogas plants, biomass gasifiers, biomass improved cook-stoves, solar photovoltaic system.

Planning of Lectures

S. No.	Topics to be covered in Lecture	Proposed No. of Lectures
1	Concept and limitation of Renewable Energy Sources (RES), Criteria for assessing the potential of RES	2
2	Classification of RES, Solar, Wind, Geothermal, Biomass, Ocean energy sources, Comparison of renewable energy sources with non renewable sources	2
3	Solar Energy: Energy available from Sun, Solar radiation data, solar energy conversion into heat through,	2
4	Flat plate and Concentrating collectors, different solar thermal devices, Principle of natural and forced convection drying system	3
5	Solar Photo voltaics: p-n junctions. Solar cells, PV systems, Stand alone, Grid connected solar power station, Calculation of energy through photovoltaic power generation and cost economics	4
6	Wind Energy: Energy available from wind, General formula, Lift and drag. Basis 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.	5
7	Bio-energy: Pyrolysis of Biomass to produce solid, liquid and gaseous fuels.	2
8	Biomass gasification, Types of gasifier, various types of biomass cook stoves for rural energy needs.	3
9	Biogas: types of biogas plants, biogas generation, factors affecting biogas generation and usages, design consideration, advantages and disadvantages of biogas spent slurry.	6
	Total	29

Planning of Practical

S. No.	Topics	Proposed No. of Practicals
1	Demonstration of different instruments used for Renewable Energy gadgets measurements	1
2	Demonstration of Box types of solar cookers	1
3	Demonstration of concentrating solar cookers	1

4	Demonstration of Solar water heating system	1
5	Demonstration of Natural convection solar dryer	1
6	Demonstration of Forced convection solar dryer	1
7	Demonstration of Solar desalination unit	1
8	Study of biogas process and different types of biogas plants	1
9	Demonstration of working of a Fixed Dome Type Biogas Plants	1
10	Demonstration of working of a Floating Dome Type Biogas Plants	1
11	Study of Biomass gasification technology and demonstration of updraft biomass gasifier for thermal utilization	1
12	Demonstration of down draft throat-less and throat type biomass gasifier	1
13	Study and Demonstration of Biomass improved cook-stoves	1
14	Demonstration of Solar photovoltaic system	1
15	Study and demonstration of biomass pyrolysis system	1
16	Demonstration and study of wind mill power generation system	1
	Total	**16**
	Suggested Readings ➢ Rai, G.D. 2013. Non-Conventional Energy Sources, Khanna Publishers, Delhi. ➢ Rai, G.D., Solar Energy Utilization, Khanna Publishers, Delhi. ➢ Khandelwal, K.C. & S. S. Mahdi. 1990. Biogas Technology- A Practical Handbook. ➢ Rathore N. S., Kurchania A. K., Panwar N. L. 2007. Non Conventional Energy Sources, Himanshu Publications. ➢ Tiwari, G.N. and Ghoshal, M.K. 2005. Renewable Energy Resources: Basic Principles and Applications. Narosa Pub. House. Delhi. ➢ Rathore N. S., Kurchania A. K., Panwar N. L. 2007. Renewable Energy, Theory and Practice, Himanshu Publications. ➢ Reed TB and Das A. Handbook of Biomass Downdraft Gasifier Engine System. The Biomass Energy Foundation Press, Colorado; 1984.	

Sr. No.	CourseName	CourseNo.	Credit	L	P	T
10	NSS/NCC/Physical Education	Phy.Edu.-2.4.10	0(0 +1)	0	0	0

SEMESTER – V

Sr. No.	CourseName	CourseNo.	Credit	L	P	T
1	Farm Machinery and Equipment-I	FMPE-3.5.1	3 (2 + 1)	2	1	0

Coursecontent:

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. Hitching systems and controls of farm machinery. Calculation of field capacities and field efficiency. Calculations for economics of machinery usage, comparison of ownership with hiring of machines. Introduction to seed-bed preparation and its classification. Familiarization with land reclamation and earth moving equipment. Introduction to machines used for primary tillage, secondary tillage, rotary tillage, deep tillage and minimum tillage. Measurement of draft of tillage tools and calculations for power requirement for the tillage machines. Introduction to tillage machines like mould-board plough, disc plough, chisel plough, sub-soiler, harrows, cultivators, Identification of major functional components. Attachments with tillage machinery. Introduction to sowing, planting & transplanting equipment. Introduction to seed drills, no-till drills, and strip-till drills. Introduction to planters, bed-planters and other planting equipment. Study of types of furrow openers and metering systems in drills and planters. Calibration of seed-drills/ planters. Adjustments during operation. Introduction to materials used in construction of farm machines. Heat treatment processes and their requirement in farm machines. Properties of materials used for critical and functional components of agricultural machines. Introduction to steels and alloys for agricultural application. Identification of heat treatment processes specially for the agricultural machinery components.

Practical

Familiarization with different farm implements and tools. Study of hitching systems, Problems on machinery management. Study of primary and secondary tillage machinery – construction, operation, adjustments and calculations of power and draft requirements. Study of sowing and planting equipment – construction, types, calculation for calibration and adjustments. Study of transplanters – paddy, vegetable, etc. Identification of materials of construction in agricultural machinery and study of material properties. Study of heat treatment processes subjected to critical components of agricultural machinery.

Planningof lectures

S. No.	Topicsto becoveredin Lecture	Proposed 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.	Hitching systems and controls of farm machinery.	2
4.	Calculation of field capacities and field efficiency.	2
5.	Calculations for economics of machinery usage, comparison of ownership with hiring of machines.	2
6.	Introduction to seed-bed preparation and its classification.	2
7.	Familiarization with land reclamation and earth moving equipment.	2
8.	Introduction to machines used for primary tillage, secondary tillage, rotary tillage, deep tillage and minimum tillage.	2
9.	Measurement of draft of tillage tools and calculations for power requirement for the tillage machines.	2
10.	Introduction to tillage machines like mould-board plough, disc plough, chisel plough, sub-soiler, harrows, cultivators etc.	2
11.	Identification of major functional components of tillage machinery. Attachments with tillage machinery. Adjustments during operation.	2

12.	Introduction to sowing, planting & transplanting equipment. Introduction to seed drills, no-till drills, and strip-till drills.	2
13.	Introduction to planters, bed-planters and other planting equipment. Calibration of seed-drills/ planters.	2
14.	Study of types of furrow openers and metering systems in drills and planters. Adjustments during operation.	2
15	Introduction to materials used in construction of farm machines. Heat treatment processes and their requirement in farm machines. Properties of materials used for critical and functional components of agricultural machines. Introduction to steels and alloys for agricultural application. Identification of heat treatment processes specially for the agricultural machinery components.	3
	Total	31

Practicals

S.No.	Topic	No. of Praticals
1.	Familiarization with different farm implements and tools.	1
2.	Study of hitching systems,	1
3.	Problems on machinery management.	2
4.	Study of primary and secondary tillage machinery – construction, operation, adjustments and calculations of power and draft requirements.	2
5.	Study of sowing and planting equipment – construction, types, calculation for calibration and adjustments.	2
6.	Study of transplanters – paddy, vegetable, etc.	2
7.	Identification of materials of construction in agricultural machinery and study of material properties. Study of heat treatment processes subjected to critical components of agricultural machinery.	3
	Total	13

Suggested Readings

Kepner RA, Roy Barger & EL Barger. Principles of Farm Machinery.
Smith HP and LH Wilkey. Farm Machinery and Equipment.
Culpin Claude. Farm Machinery.
Srivastava AC. Elements of Farm Machinery.
Lal Radhey and AC Datta. Agricultural Engineering.

Sr. No.	Course Name	Course No.	Credit	L	P	T
2	Tractor Systems and Controls	FMPE-3.5.2	3 (2 + 1)	2	1	3

Course content :

Theory

Study of need for transmission system in a tractor. Transmission system – types, major functional systems. Study of clutch – need, types, functional requirements, construction and principle of operation. Familiarization with single plate, multi-plate, centrifugal and dual clutch systems. Study of Gear Box – Gearing theory, principle of operation, gear box types, functional requirements, and calculation for speed ratio. Study of differential system – need, functional components, construction, calculation for speed reduction. Study of need for a final drive. Study of Brake system – types, principle of operation, construction, calculation for braking torque. Study of steering system – requirements, steering geometry characteristics, functional components, calculation for turning radius. Familiarization with Ackerman steering. Steering systems in track type tractors. Study of Hydraulic system in a tractor – Principle of operation, types, main functional components, functional requirements. Familiarization with the Hydraulic system adjustments and ADDC. Study of tractor power outlets – PTO. PTO standards, types and functional requirements. Introduction to traction. Traction terminology. Theoretical calculation of shear force and rolling resistance on traction device. Study of wheels and tyres – Solid tyres and pneumatic tyres, tyre construction and tyre specifications. Study of traction aids. Study of tractor mechanics – forces acting on the tractor. Determination of CG of a tractor. Determination and importance of moment of inertia of a tractor. Study of tractor static equilibrium, tractor stability especially at turns. Determination of maximum drawbar pull. Familiarization with tractor as a spring-mass system. Ergonomic considerations and operational safety. Introduction to tractor testing. Deciphering the engine test codes.

Practical

Introduction to 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 and final drive and planetary gears; Study of brake systems and some design problems; Steering geometry and adjustments; Study of hydraulic systems in a tractor, hydraulic trainer and some design problems; Appraisal of various controls in different makes tractors in relation to anthropometric measurements. Determination of location of CG of a tractor, Moment of Inertia of a tractor. Traction performance of a traction wheel.

Planning of lectures

S. No.	Topics to be covered in Lecture	Proposed No. of Lectures
1	Study of need for transmission system in a tractor. Transmission system –types, major functional systems. Study of clutch – need, types, functional requirements, construction and principle of operation.	2
2	Familiarization with single plate, multi-plate, centrifugal and dual clutch systems.	3
3	Study of Gear Box – Gearing theory, principle of operation, gear box types, functional requirements, and calculation for speed ratio.	3
4	Study of differential system – need, functional components, construction, calculation for speed reduction. Study of need for a final drive.	2
5	Study of Brake system – types, principle of operation, construction, calculation for braking torque.	2
6	Study of steering system – requirements, steering geometry characteristics, functional components, calculation for turning radius. Familiarization with Ackerman steering. Steering systems in track type tractors.	3
7	Study of Hydraulic system in a tractor – Principle of operation, types, main functional components, functional requirements. Familiarization with the Hydraulic system adjustments and ADDC.	3
8	Study of tractor power outlets – PTO. PTO standards, types and functional requirements.	1
9	Introduction to traction. Traction terminology. Theoretical calculation of shear force and rolling resistance on traction device.	2

10	Study of wheels and tyres – Solid tyres and pneumatic tyres, tyre construction and tyre specifications. Study of traction aids.	2
11	Study of tractor mechanics – forces acting on the tractor. Determination of CG of a tractor.	2
12	Determination and importance of moment of inertia of a tractor. Study of tractor static equilibrium, tractor stability especially at turns.	2
12	Determination of maximum drawbar pull. Familiarization with tractor as a spring-mass system.	2
13	Ergonomic considerations and operational safety.	2
14	Introduction to tractor testing. Deciphering the engine test codes.	1
	Total	**32**

Practicals

S. No.	**Topic**	**No. of Practicals**
1	Introduction to transmission systems and components	1
2	Study of clutch functioning, parts and design problem on clutch system	2
3	Study of different types of gear box, calculation of speed ratios, design problems on gear box	2
4	Study on differential and final drive and planetary gears	1
5	Study of brake systems and some design problems	1
6	Steering geometry and adjustments;	1
7	Study of hydraulic systems in a tractor hydraulic trainer and some design problems	2
8	Appraisal of various controls in different makes tractors in relation to anthropometric measurements	2
9	Determination of location of CG of a tractor, Moment of Inertia of a tractor.	1
	Determination of Moment of Inertia of a tractor.	1
10	Traction performance of a traction wheel	2
	Total	**16**

Reference Books:

1. Liljedahl J B and Others. Tractors and Their Power Units.
2. Rodichev V and G Rodicheva. Tractors and Automobiles.
3. Singh Kirpal. Automobile Engineering – Vol I.
4. Heitner Joseph. Automotive Mechanics: Principles and Practices.
5. C.B.Richey. Agricultural Engineering Handbook.
6. John Deere. Fundamentals of Service Hydraulics.
7. Relevant BIS Test Codes for Tractors.

Sr. No.	Course Name	Course No.	Credit	L	P	T
3	Agricultural Structures and Environmental Control	PFE-3.5.3	3 (2+1)	2	1	0

Course content:

Theory:

Planning and layout of farmstead. Scope, importance and need for environmental control, physiological reaction of livestock environmental factors, environmental control systems and their design, control of temperature, humidity and other air constituents by ventilation and other methods, Livestock production facilities, BIS Standards for dairy, piggery, poultry and other farm structures. Design, construction and cost estimation of farm structures; animal shelters, compost pit, fodder silo, fencing and implement sheds, barn for cows, buffalo, poultry, etc. Storage of grains, Causes of spoilage, Water activity for low and high moisture food and its limits for storage, Moisture and temperature changes in grain bins; Traditional storage structures and their improvements, Improved storage structures (CAP, hermetic storage, Pusa bin, RCC ring bins), Design consideration for grain storage godowns, Bag storage structures, Shallow and Deep bin, Calculation of pressure in bins, Storage of seeds. Rural living and development, rural roads, their construction cost and repair and maintenance. Sources of water supply, norms of water supply for human being and animals, drinking water standards and water treatment suitable to rural community. Site and orientation of building in regard to sanitation, community sanitation system; sewage system and its design, cost and maintenance, design of septic tank for small family. Estimation of domestic power requirement, source of power supply and electrification of rural housing

Practical:

Measurements for environmental parameters and cooling load of a farm building, Design and layout of a dairy farm, Design and layout of a poultry house, Design and layout of a goat house/sheep house, Design of a farm fencing system, Design of a feed/fodder storage structures, Design of grain storage structures, Design and layout of commercial bag and bulk storage facilities, Study and performance evaluation of different domestic storage structure, Estimation of a Farm building.

Planning of lectures

S. No.	Topics to be covered in Lecture	Proposed No. of Lectures
1	Planning and layout of farmstead	1
2	Scope, importance and need for environmental control	1
3	physiological reaction of livestock environmental factors	1
4	environmental control systems and their design,	1
5	control of temperature, humidity and other air constituents by ventilation and other methods	2
6	Livestock production facilities, BIS Standards for dairy, piggery, poultry 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	Storage of grains, Causes of spoilage, Water activity for low and high moisture food and its limits for storage	3
9	Moisture and temperature changes in grain bins; Traditional storage structures and their improvements, Improved storage structures (CAP, hermetic storage, Pusa bin, RCC ring bins), Design consideration for grain storage godowns, Bag storage structures, Shallow and Deep bin, Calculation of pressure in bins, Storage of seeds	4
10	Rural living and development, rural roads, their construction cost and repair and maintenance	2
11	Sources of water supply, norms of water supply for human being and animals	2
12	drinking water standards and water treatment suitable to rural community	2
13	Site and orientation of building in regard to sanitation, community sanitation	4

	system; sewage system and its design, cost and maintenance, design of septic tank for small family.	
14	Estimation of domestic power requirement, source of power supply and electrification of rural housing.	3
Total		**32**
Practical		
S.No.	3. **Topic**	**No. of Practical**
1	Measurements for environmental parameters and cooling load of a farm building	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 house/sheep house	1
5	Design of a farm fencing system	1
6	Design of a feed/fodder storage structures	2
7	Design of grain storage structures	2
8	Design and layout of commercial bag and bulk storage facilities	2
9	Study and performance evaluation of different domestic storage structure	2
10	Estimation of a Farm building	2
	Total	**16**

Suggested Readings:

Pandey, P.H. Principles and practices of Agricultural Structures and Environmental Control, Kalyani Publishers, Ludhiana.

Ojha, T.P and Michael, A.M. Principles of Agricultural Engineering, Vol. I, Jain Brothers, Karol Bag, New Delhi.

Nathonson, J.A. Basic Environmental Technology, Prentice Hall of India, New Delhi.

Venugopal Rao, P. Text Book of Environmental Engineering, Prentice Hall of India, New Delhi.

Garg, S.K. Water Supply Engineering, Khanna Publishers, New Delhi-6.

Dutta, B.N. Estimating and Costing in Civil Engineering, Duttta & CO, Lucknow.

Khanna, P.N. Indian Practical Civil Engineer's Hand Book, Engineer's Publishers, New Delhi.

Sahay, K.M. and Singh, K.K. Unit Operations of Agricultural Processing, Vikas publishing pvt. Ltd, Noida.

Banerjee, G.C. A Text Book of Animal Husbandry, Oxford IBH Publishing Co, New Delhi

Sr. No.	Course Name	Course No.	Credit	L	P	T
4	Post Harvest Engineering of Cereals, Pulses and Oil Seeds	PFE-3.5.4	3 (2+1)	2	1	0

Course content:

Theory

Cleaning and grading, aspiration, scalping; size separators, screens, sieve analysis, capacity and effectiveness of screens. Various types of separators: specific gravity, magnetic, disc, spiral, pneumatic, inclined draper, velvet roll, colour sorters, cyclone, shape graders. Size reduction: principle, Bond's law, Kick's law, Rittinger's law, procedure (crushing, impact, cutting and shearing), Size reduction machinery: Jaw crusher, Hammer mill, Plate mill, Ball mill. Material handling equipment. Types of conveyors: Belt, roller, chain and screw. Elevators: bucket, Cranes & hoists. Trucks (refrigerated/ unrefrigerated), Pneumatic conveying. Drying: moisture content and water activity; Free, bound 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 period, drying equations, Mass and energy balance, Shedd's equation, Dryer performance, Different methods of drying, batch-continuous; mixing-non-mixing, Sun-mechanical, conduction, convection, radiation, superheated steam, tempering during drying, Different types of grain dryers: bin, flat bed, LSU, columnar, RPEC, fluidized, rotary and tray. Mixing: Theory of mixing of solids and pastes, Mixing index, types of mixers for solids, liquid foods and pastes. Milling of rice: Conditioning and parboiling, advantages and disadvantages, traditional methods, CFTRI and Jadavpur methods, Pressure parboiling method, Types of rice mills, Modern rice milling, different unit operations and equipment. Milling of wheat, unit operations and equipment. Milling of pulses: traditional milling methods, commercial methods, pre-conditioning, dry milling and wet milling methods: CFTRI and Pantnagar methods. Pulse milling machines, Milling of corn and its products. Dry and wet milling. Milling of oilseeds: mechanical expression, screw press, hydraulic press, solvent extraction methods, preconditioning of oilseeds, refining of oil, stabilization of rice bran., Extrusion cooking: principle, factors affecting, single and twin screw extruders. By-products utilization.

Practical

Performance evaluation of different types of cleaners and separators, Determination of separation efficiency, Study of different size reduction machines and performance evaluation, Determination of fineness modulus and uniformity index, Study of different types of conveying and elevating equipments, Study of different types of mixers. 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 various types of dryers, Study of different equipments in rice mills and their performance evaluation, Study of different equipments in pulse mills and their performance evaluation, Study of different equipments in oil mills and their performance evaluation, Type of process flow charts with examples relating to processing of cereals pulses and oil seeds, Visit to grain processing industries.

Planning of lectures

S. No.	Topics to be covered in Lecture	Proposed No. of Lectures
1	Cleaning and grading, aspiration, scalping; size separators, screens, sieve analysis, capacity and effectiveness of screens. Various types of separators: specific gravity, magnetic, disc, spiral, pneumatic, inclined draper, velvet roll, colour sorters, cyclone, shape graders.	4
2	Size reduction: principle, Bond's law, Kick's law, Rittinger's law, procedure (crushing, impact, cutting and shearing), Size reduction machinery: Jaw crusher, Hammer mill, Plate mill, Ball mill.	4
3	Material handling equipment. Types of conveyors: Belt, roller, chain and screw. Elevators: bucket, Cranes & hoists. Trucks (refrigerated/ unrefrigerated), Pneumatic conveying.	4
4	Drying: moisture content and water activity; Free, bound 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	6

	period, drying equations, Mass and energy balance, Shedd's equation, Dryer performance, Different methods of drying, batch-continuous; mixing-non-mixing, Sun-mechanical, conduction, convection, radiation, superheated steam, tempering during drying, Different types of grain dryers: bin, flat bed, LSU, columnar, RPEC, fluidized, rotary and tray.	
5	Mixing: Theory of mixing of solids and pastes, Mixing index, types of mixers for solids, liquid foods and pastes.	2
6	Milling of rice: Conditioning and parboiling, advantages and disadvantages, traditional methods, CFTRI and Jadavpur methods, Pressure parboiling method, Types of rice mills, Modern rice milling, different unit operations and equipment.	4
7	Milling of wheat, unit operations and equipment.	2
8	Milling of pulses: traditional milling methods, commercial methods, pre-conditioning, dry milling and wet milling methods: CFTRI and Pantnagar methods. Pulse milling machines, Milling of corn and its products. Dry and wet milling.	2
9	Milling of oilseeds: mechanical expression, screw press, hydraulic press, solvent extraction methods, preconditioning of oilseeds, refining of oil, stabilization of rice bran.	2
10	Extrusion cooking: principle, factors affecting, single and twin screw extruders. By-products utilization.	2
Total		**32**

Practical

S.No.	4. **Topic**	**No. of Practical**
1	Study of different types of cleaners and separators and performance evaluation	1
2	Determination of separation/cleaning efficiency	1
3	Study of different size reduction machines and performance evaluation	1
4	Determination of fineness modulus and uniformity index	1
5	Study of different types of conveying and elevating equipments	1
6	Study of different types of mixers	1
7	Measurement of moisture content: dry basis and wet basis	1
8	Study on drying characteristics of grains and determination of drying constant	1
9	Determination of EMC (Static/dynamic method)	1
10	Study of various types of dryers	1
11	Study of different equipments in rice mills and performance evaluation	1
12	Study of different equipments in pulse mills and performance evaluation	1
13	Study of different equipments in oil mills and performance evaluation	1
14	Process flow charts related to processing of cereals and pulses	1
15	Process flow charts related to processing of oil seeds	1
16	Visit to grain processing industries	1
	Total	**16**

Suggested Readings

Chakraverty, A. Post Harvest Technology of cereals, pulses and oilseeds. Oxford & IBH publishing Co. Ltd., New Delhi.

)ash, S.K., Bebartta, J.P. and Kar, A. Rice Processing and Allied Operations. Kalyani Publishers, New Delhi.

Sahay, K.M. and Singh, K.K. 1994. Unit operations of Agricultural Processing. Vikas Publishing house Pvt. Ltd. New Delhi.

Geankoplis C. J. Transport processes and unit operations, Prentice Hall of India Pvt Ltd, New Delhi

.L. 2003. Unit Operations in Food Processing. Pergamon Press. Oxford. U.K.

Henderson, S.M., and Perry, R. L. Agricultural Process Engineering, Chapman and hall, London

McCabe, W.L., Smith J.C. and Harriott, P. Unit operations of Chemical Engineering. McGraw Hill.

Singh, R. Paul. and Heldman, R.Dennis. 2004. Introduction to Food Engineering. 3rd Edition. Academic Press, London.

Brooker, D.B., Bakker-Arkema,F.W., Hall, C.W. 1992. Drying and storage of grains and oilseeds, AVI publication

Sr. No.	Course Name	Course No.	Credit	L	P	T
5	Soil and Water Conservation Engineering	SWCE-3.5.5	2 (2 + 1)	2	1	0

Course content :

Theory: 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 EI_{30} methods. Soil erodibility - topography, crop management and conservation practice factors. Measurement of soil erosion - Runoff plots, soil samplers. 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 stonewall and trenching. Gully and ravine reclamation - principles of gully control - vegetative measures, temporary structures and diversion drains. Grassed waterways and design. Wind erosion- Factors affecting, mechanics, soil loss estimation and control measures - vegetative, mechanical measures, wind breaks and shelter belts and stabilization of sand dunes.Land capability classification. Rate of sedimentation, silt monitoring and storage loss in tanks..

Practical: Study of different types and forms of water erosion. Exercises on 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 for soil loss estimation by USLE and MUSLE. Exercises on soil loss estimation/measuring techniques. 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 dry method. Design and layout of contour bunds. Design and layout of graded bunds. Design and layout of broad base terraces. Design and layout of bench terraces. Design of vegetative waterways. Exercises on rate of sedimentation and storage loss in tanks. Computation of soil loss by wind erosion. Design of shelterbelts and wind breaks for wind erosion control. Visit to soil erosion sites and watershed project areas for studying erosion control and water conservation measures.

Planning of lectures

S. 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	2
2	Water erosion - Mechanics and forms - splash, sheet, rill, gully, ravine and stream bank erosion	3
3	Gullies - Classification, stages of development.	2
4	Soil loss estimation – Universal soil loss equation (USLE) and modified USLE	2
5	Rainfall erosivity - estimation by KE>25 and EI_{30} methods	1
6	Soil erodibility - topography, crop management and conservation practice factors	2
7	Measurement of soil erosion - Runoff plots, soil samplers	2
8	Water erosion control measures - agronomical measures - contour farming, strip cropping, conservation tillage and mulching	3
9	Engineering measures– Bunds and terraces	3
10	Bunds - contour and graded bunds - design and surplussing arrangements	2
11	Terraces - level and graded broad base terraces, bench terraces - planning, design and layout procedure, contour stonewall and trenching	3
12	Gully and ravine reclamation - principles of gully control - vegetative measures, temporary structures and diversion drains	2
13	Grassed waterways and design	1
14	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

15	Land capability classification. Rate of sedimentation, silt monitoring and storage loss in tanks.	2
Total		**32**

Practicals

S.No.	5. **Topic**	No. of Practicals
1	Study of different types and forms of water erosion	1
2	Exercises on computation of rainfall erosivity index	1
3	Computation of soil erodibility index in soil loss estimation	1
4	Determination of length of slope (LS) and cropping practice (CP) factors for soil loss estimation by USLE and MUSLE	1
5	Exercises on soil loss estimation/measuring techniques	1
6	Study of rainfall simulator for erosion assessment	1
7	Estimation of sediment rate using Coshocton wheel sampler and multi-slot devisor	1
8	Determination of sediment concentration through oven dry method	1
9	Design and layout of contour bunds	1
10	Design and layout of graded bunds	1
11	Design and layout of broad base terraces	1
12	Design and layout of bench terraces	1
13	Design of vegetative waterways	1
14	Exercises on rate of sedimentation and storage loss in tanks	1
15	Computation of soil loss by wind erosion	1
16	Design of shelterbelts and wind breaks for wind erosion control	1
17	Visit to soil erosion sites and watershed project areas for studying erosion control and water conservation measures	1
	Total	**17**

Suggested Readings

Singh Gurmel, C. Venkataraman, G. Sastry and B.P. Joshi. 1996. Manual of Soil and Water Conservation Practices. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.

Mahnot, S.C. 2014. Soil and Water Conservation and Watershed Management. International Books and Periodicals Supply Service, New Delhi.

Mal, B.C. 2014. Introduction to Soil and Water Conservation Engineering. 2014. Kalyani Publishers.

Michael, A.M. and T.P. Ojha. 2003. Principles of Agricultural Engineering. Volume II. 4th Edition, Jain Brothers, New Delhi.

Murthy, V.V.N. 2002. Land and Water Management Engineering. 4th Edition, Kalyani Publishers, New Delhi.

Norman Hudson. 1985. Soil Conservation. Cornell University Press, Ithaka, New York, USA.

Frevert, R.K., G.O. Schwab, T.W. Edminster and K.K. Barnes. 2009. Soil and Water Conservation Engineering, 4th Edition, John Wiley and Sons, New York.

Suresh, R. 2014. Soil and Water Conservation Engineering. Standard Publisher Distributors, New Delhi.

Sr. No.	Course Name	Course No.	Credit	L	P	T
6	**Watershed Planning and Management**	**SWCE-3.5.6**	**2 (1 + 1)**	**1**	**1**	**0**

Course content :

Theory: Watershed - introduction and characteristics. Watershed development - problems and prospects, investigation, topographical survey, soil characteristics, vegetative cover, present land use practices and socio-economic factors. 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. 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. Watershed programme - execution, follow-up practices, maintenance, monitoring and evaluation. Participatory watershed management - role of watershed associations, user groups and self-help groups. Planning and formulation of project proposal for watershed management programme including cost-benefit analysis..

Practical: Exercises on delineation of watersheds using toposheets. Surveying and preparation of watershed map. Quantitative analysis of watershed characteristics and parameters. Watershed investigations for planning and development. Analysis of hydrologic data for planning watershed management. Water budgeting of watersheds. Prioritization of watersheds based on sediment yield index. Study of functional requirement of watershed development structures. Study of watershed management technologies. Practice on softwares for analysis of hydrologic parameters of watershed. Study of role of various functionaries in watershed development programmes. Techno-economic viability analysis of watershed projects. Visit to watershed development project areas.

Planning of lectures

S. No.	Topics to be covered in Lecture	Proposed No. of Lectures
1	Watershed - introduction and characteristics	1
2	Watershed development - problems and prospects, investigation, topographical survey,	1
3	Watershed development - soil characteristics, vegetative cover, present land use practices and socio-economic factors	1
4	Watershed management - concept, objectives, factors affecting, watershed planning based on land capability classes,	1
5	Watershed management - hydrologic data for watershed planning, watershed codification	1
6	Watershed management - delineation and prioritization of watersheds – sediment yield index	1
7	Water budgeting in a watershed	1
8	Management measures - rainwater conservation technologies - *in-situ* and *ex-situ* storage	1
9	Management measures - water harvesting and recycling	1
10	Dry farming techniques - inter-terrace and inter-bund land management	1
11	Integrated watershed management - concept, components, arable lands - agriculture and horticulture, non-arable lands - forestry, fishery and animal husbandry	1
12	Effect of cropping systems, land management and cultural practices on watershed hydrology	1
13	Watershed programme - execution, follow-up practices, maintenance, monitoring and evaluation	1
14	Participatory watershed management - role of watershed associations, user groups and self-help groups	1
15	Planning and formulation of project proposal for watershed management	2

	programme including cost-benefit analysis	
Total		**16**

Practicals

S.No.	6. **Topic**	No. of Practicals
1	Exercises on delineation of watersheds using toposheets	1
2	Surveying and preparation of watershed map	2
3	Quantitative analysis of watershed characteristics and parameters	1
4	Watershed investigations for planning and development	2
5	Analysis of hydrologic data for planning watershed management	2
6	Water budgeting of watersheds	1
7	Prioritization of watersheds based on sediment yield index	1
8	Study of functional requirement of watershed development structures	1
9	Study of watershed management technologies	1
10	Practice on softwares for analysis of hydrologic parameters of watershed	2
11	Study of role of various functionaries in watershed development programmes	1
12	Techno-economic viability analysis of watershed projects	1
13	Visit to watershed development project areas	1
	Total	**17**

Suggested Readings

Ghanshyam Das. 2008. Hydrology and Soil Conservation Engineering: Including Watershed Management. 2nd Edition, Prentice-Hall of India Learning Pvt. Ltd., New Delhi.

Katyal, J.C., R.P. Singh, Shriniwas Sharma, S.K. Das, M.V. Padmanabhan and P.K. Mishra. 1995. Field Manual on Watershed Management. CRIDA, Hyderabad.

Mahnot, S.C. 2014. Soil and Water Conservation and Watershed Management. International Books and Periodicals Supply Service. New Delhi.

Sharda, V.N., A.K. Sikka and G.P. Juyal. 2006. Participatory Integrated Watershed Management: A Field Manual. Central Soil and Water Conservation Research and Training Institute, Dehradun.

Singh, G.D. and T.C. Poonia. 2003. Fundamentals of Watershed Management Technology. Yash Publishing House, Bikaner.

Singh, P.K. 2000. Watershed Management: Design and Practices. E-media Publications, Udaipur.

Singh, R.V. 2000. Watershed Planning and Management. Yash Publishing House, Bikaner.

Tideman,E.M. 1999. Watershed Management: Guidelines for Indian Conditions. Omega Scientific Publishers, New Delhi.

Sr. No	Course Name	Course No.	Credit	L	P	T
7	**Drainage Engineering**	**IDE-3.5.7**	**2(1+1)**	**1**	**1**	**0**

Course Content:

Theory: Water logging- causes and impacts; drainage, objectives of drainage, familiarization with the drainage problems of the state; surface drainage coefficient, types of surface drainage, design of surface drains; sub-surface drainage: purpose and benefits, investigations of design parameters-hydraulic conductivity, drainable porosity, water table; 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; mole drains; salt balance, reclamation of saline and alkaline soils, leaching requirements, conjunctive use of fresh and saline water.

Practical:*In-situ* measurement of hydraulic conductivity by single auger hole and inverse auger hole method; Estimation of drainage coefficients; installation of piezometer and observation wells; preparation of iso-bath and isobar maps; determination of drainable porosity; design of surface drainage systems; design of gravel envelop; design of subsurface drainage systems; determination of chemical properties of soil and water; study of drainage tiles and pipes; installation of sub-surface drainage system; cost analysis of surface and sub-surface drainage system.

Planning of Lecture

Sr. No	Topics to be covered in Lecture	Proposed No. of Lecture
1.	Water logging- causes and impacts; drainage, objectives of drainage, familiarization with the drainage problems of the state	2
2.	Surface drainage coefficient, types of surface drainage, design of surface drains	2
3.	Sub-surface drainage: purpose and benefits, investigations of design parameters-hydraulic conductivity, drainable porosity, water table	2
4.	Derivation of Hooghoudt's and Ernst's drain spacing equations	2
5.	Design of subsurface drainage system; drainage materials, drainage pipes, drain envelope; layout, construction and installation of drains	3
6.	Drainage structures; vertical drainage; bio-drainage; mole drains	2
7.	Salt balance, reclamation of saline and alkaline soils, leaching requirements	2
8.	Conjunctive use of fresh and saline water	2
	Total	**17**

Practical

Sr. No	Topics	No. of Practical
1.	*In-situ* measurement of hydraulic conductivity by single auger hole and inverse auger hole method	1
2.	Estimation of drainage coefficients	1
3.	Installation of piezometer and observation wells	1
4.	Preparation of iso-bath and isobar maps	1
5.	Determination of drainable porosity	1
6.	Design of surface drainage systems	3
7.	Design of gravel envelop	1
8.	Design of subsurface drainage systems	3
9.	Determination of chemical properties of soil and water	1
10.	Study of drainage tiles and pipes	1
11.	Installation of sub-surface drainage system	1
12.	Cost analysis of surface and sub-surface drainage system.	1
13.	Determination of gypsum requirement for land reclamation	1
	Total	**17**

Suggested Readings

Bhattacharya AK and Michael AM. 2013. Land Drainage, Principles , Methods and Applications. Vikas Publication House, Noida (UP).

Ritzema H.P.1994 Drainage Principles and Applications, ILRI Publication 16, Second Edition (Completely Revised).

Michael AM. and Ojha TP. 2014. Principles of Agricultural Engineering Vol-II 5th Edition. Jain Brothers Publication, New Delhi.

Kadam U.S., Thokal R.T., Gorantiwar S.D. and Powar A.G. 2007. Agricultural Drainage-Principles and Practices, Westville Publishing House.

FAO Irrigation and Drainage Paper No. 6, 9, 15, 16, 28 and 38. Rome, Italy.

Sr. No.	Course Name	Course No.	Credit	L	P	T
8	**Renewable Power Sources**	**REE-3.5.8**	**3 (2+1)**	**2**	**1**	**0**

Course Content:

Energy consumption pattern & energy resources in India. Renewable energy options, potential and utilization. Biogas technology and mechanisms, generation of power from biogas, Power generation from urban, municipal and industrial waste. Design & use of different commercial sized biogas plant. Solar thermal and photovoltaic Systems for power generation. Calculation of energy through photovoltaic power generation and cost economics, Central receiver (Chimney) and distributed type solar power plant, OTEC, MHD, hydrogen and fuel cell technology. Wind farms. Aero-generators. Wind power generation system. Power generation from biomass (gasification & Dendro thermal), Mini and micro small hydel plants. Fuel cells and its associated parameters.

Practical

Performance evaluation of solar water heater; Performance evaluation of solar cooker; Characteristics of solar photovoltaic panel; evaluation of solar air heater/dryer; Performance evaluation of biomass gasifier engine system (throatless & downdraft), Performance evaluation of a fixed dome type biogas plant; Performance evaluation of floating drum type biogas plant; Estimation of calorific value of biogas & producer gas; Testing of diesel engine operation using dual fuel and gas alone.

Planning of Lectures

S. No.	Topics to be covered in Lecture	Proposed No. of Lectures
1	Energy consumption pattern & energy resources in India.	2
2	Renewable energy options, potential and utilization.	2
3	Biogas technology and mechanisms, generation of power from biogas, Power generation from urban, municipal and industrial waste. Design & use of different commercial sized biogas plant.	5
4	Solar thermal and photovoltaic Systems for power generation.	2
5	Calculation of energy through photovoltaic power generation and cost economics	3
6	Central receiver (Chimney) and distributed type solar power plant	3
7	OTEC, MHD, hydrogen and fuel cell technology	2
8	Wind farms. Aero-generators. Wind power generation system.	3
9	Power generation from biomass (gasification & Dendro thermal)	3
10	Mini and micro small hydel plants.	2
11	Fuel cells and its associated parameters.	2
	Total	29

Planning of Practical

S. No.	Topics	Proposed No. of Practicals
1	Performance evaluation of solar water heater;	1
2	Performance evaluation of solar cooker;	1
3	Characteristics of solar photovoltaic panel;	1
4	Performance evaluation of solar air heater/dryer	1
5	Study and demonstration of Gas Chromatography for producer gas estimation	1
6	Study and demonstration of orsat apparatus for biogas gas estimation	1
7	Determination of the calorific value	1
8	Estimation of Ash content of Biomass	1
9	Estimation of Moisture content of Biomass	1
10	Estimation of fixed carbon and volatile matter of Biomass	1
11	Performance evaluation of biomass gasifier engine system (throatless & downdraft),	1
12	Performance evaluation of a fixed dome type biogas plant;	1
13	Performance evaluation of floating drum type biogas plant;	1

14	Testing of diesel engine operation using dual fuel and gas alone.	1
15	Study and demonstration of Mini and micro small hydel plants	1
16	Study and demonstration of Fuel cells	1
	Total	**16**

Suggested Readings

Garg H.P. 1990. Advances in Solar Energy Technology; D. Publishing Company, Tokyo.

Alan L: Farredbruch & R.H. Buse. 1983. Fundamentals of Solar Academic Press, London.

Bansal N.K., Kleemann M. & Meliss Michael. 1990. Renewable Energy Sources & Conversion Technology; Tata Mecgrow Publishing Company, New Delhi.

Rathore N. S., Kurchania A. K. & N.L. Panwar. 2007. Non Conventional Energy Sources, Himanshu Publications.

Mathur, A.N. & N.S. Rathore. 1992. Biogas Production Management & Utilization. Himanshu Publications, Udaipur.

Khandelwal, K.C. & S.S. Mahdi. 1990. Biogas Technology.

Rai, G.D. 2013. Non-Conventional Energy Sources, Khanna Publishers, Delhi.

Mathur A.N. & N.S. Rathore. Renewable Energy Sources Bohra Ganesh Publications, Udaipur.

Reed TB and Das A. Handbook of Biomass Downdraft Gasifier Engine System. The Biomass Energy Foundation Press, Colorado; 1984.

Sr. No.	Course Name	Course No.	Credit	L	P	T
9	**Skill Development Training – I (Student READY) Registration Only**	**CAE-3.5.9**	**5 (0+5)**	**0**	**5**	**0**
At the end of 4th Semester 4 weeks for training & 1 week for evaluation						

SEMESTER – VI

Sr. No.	Course Name	Course No.	Credit	L	P	T
1	Computer Programming and Data Structures	CSE-3.6.1	3 (1 + 2)	1	2	0

Course content:

Theory: Introduction to high level languages, Primary data types and user defined data types, Variables, typecasting, Operators, Building and evaluating expressions, Standard library functions, Managing input and output, Decision making, Branching, Looping, Arrays, User defined functions, passing arguments and returning values, recursion, scope and visibility of a variable, String functions, Structures and union, Pointers, Stacks, Push/Pop operations, Queues, Insertion and deletion operations, Linked lists.

Practical: Familiarizing with Turbo C IDE; Building an executable version of C program; 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; Developing structures and union; Creating user defined functions; Using local, global & external variables; Using pointers; Implementing Stacks; Implementing push/pop functions; Creating queues; Developing linked lists in C language; Insertion/Deletion in data structures.

Planning of lectures

S. No.	Topics to be covered in Lecture	Proposed No. of Lectures
1	Introduction to high-level languages.	1
2	Primary data types and user defined data types.	1
3	Variables, typecasting, Operators and expression evaluating	3
4	Managing input and output	1
5	Decision making	2
6	Looping & Array	2
7	User defined functions & scope and visibility of a variable	2
8	String functions	1
9	Structures and union	1
10	Pointers, Stack, Queue and Link list	2
	Total	**16**

Practicals

S.No.	7. Topic	No. of Tutorials
1	Familiarizing with Turbo C ID	2
3	Developing, Debugging and executing simple C programs	4
4	Developing programs using Decision making statements	2
5	Developing programs using Entry control loop statements	3
6	Developing programs using Exit control loop statements	2
7	Developing programs using nested control structures	2
8	Familiarizing with one dimensional arrays	2
9	Familiarizing with two dimensional arrays	2
10	Developing programs using string functions	2
11	Familiarizing with structures and union	1
12	Creating user defined functions	2
13	Developing programs using local, global & external variables	1
14	Familiarizing with pointers	1
15	Implementing Stacks , Queue, Link list	4
	Total	**30**

Suggested Reading

Rajaraman V. 1985. Computer Oriented Numerical Methods. Prentice Hall of India. Pvt. Ltd., New Delhi.
Balagurusamy E. 1990. Programming in 'C'. Tata McGraw Hill Publishing Co. Ltd., 12/4 Asaf Ali Road,

New Delhi.
Rajaraman V. 1995. Computer Programming in 'C'. Prentice Hall of India Pvt.Ltd., New Delhi.
Bronson G and Menconi S. 1995. A First Book of 'C' Fundamentals of 'C' Programming. Jaico Publishing House, New Delhi
Sahni S.. Data Structures, Algorithms and Applications in C++. University press (India) Pvt Ltd / Orient Longman Pvt. Ltd.
Michael T. Goodrich, R. Tamassia and D Mount. Data structures and Algorithms in C++. Wiley Student Edition, John Wiley and Sons.
Mark Allen Weiss. Data Structures and Algorithm Analysis in C++. Pearson Education.
Augenstein, Langsam and Tanenbaum. Data structures using C and C++. PHI/Pearson Education.
Drozdek Adam. Data Structures and Algorithms in C++. Vikas Publishing House / Thomson International Student Edition.
Agarwal, Ajay. The Complete Reference Guide: Data Structure through C. ISBN: 8178840448; Publisher: Cyber Tech Publications.

Sr. No.	Course Name	Course No.	Credit	L	P	T
2	Farm Machinery and Equipment-II	FMPE-3.6.2	3 (2 + 1)	2	1	0

Course content:

Theory:

Introduction to plant protection equipment – sprayers and dusters. Classification of sprayers and sprays. Types of nozzles. Calculations for calibration of sprayers and chemical application rates. Introduction to interculture equipment. Use of weeders – manual and powered. Study of functional requirements of weeders and main components. Familiarization of fertilizer application equipment. Study of harvesting operation – harvesting methods, harvesting terminology. Study of mowers – types, constructional details, working and adjustments. Study of shear type harvesting devices – cutter bar, inertial forces, counter balancing, terminology, cutting pattern. Study of reapers, binders and windrowers – principle of operation and constructional details. Importance of hay conditioning, methods of hay conditioning, and calculation of moisture content of hay. Introduction to threshing systems – manual and mechanical systems. Types of threshing drums and their applications. Types of threshers- tangential and axial, their constructional details and cleaning systems. Study of factors affecting thresher performance. Study of grain combines, combine terminology, classification of grain combines, study of material flow in combines. Computation of combine losses, study of combine troubles and troubleshooting. Study of chaff cutters and capacity calculations. Study of straw combines – working principle and constructional details. Study of root crop diggers – principle of operation, blade adjustment and approach angle, and calculation of material handled. Study of potato and groundnut diggers. Study of Cotton harvesting – Cotton harvesting mechanisms, study of cotton pickers and strippers, functional components. Study of maize harvesting combines. Introduction to vegetables and fruit harvesting equipment and tools.

Practical:

Familiarization with plant protection and interculture equipment. Study of sprayers, types, functional components. 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. Familiarization with threshing systems, cleaning systems in threshers. Calculations of losses in threshers. Familiarization with 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. Familiarization with the working of cotton and maize harvesters. Familiarization with vegetable and fruit harvesters.

Planning of lectures

S. No.	Topics to be covered in Lecture	Proposed No. of Lectures
1.	Introduction to plant protection equipment – sprayers and dusters. Classification of sprayers and sprays. Types of nozzles. Calculations for calibration of sprayers and chemical application rates.	2
2.	Introduction to interculture equipment. Use of weeders – manual and powered. Study of functional requirements of weeders and main components. Familiarization of fertilizer application equipment.	2
3.	Study of harvesting operation – harvesting methods, harvesting terminology.	2
4.	Study of mowers – types, constructional details, working and adjustments. Study of shear type harvesting devices – cutter bar, inertial forces, counter balancing, terminology, cutting pattern.	4
5.	Study of reapers, binders and windrowers – principle of operation and constructional details.	2
6.	Importance of hay conditioning, methods of hay conditioning, and calculation of moisture content of hay.	2
7.	Introduction to threshing systems – manual and mechanical systems. Types of threshing drums and their applications. Types of threshers- tangential and	2

	axial, their constructional details and cleaning systems. Study of factors affecting thresher performance.	
8.	Study of grain combines, combine terminology, classification of grain combines, study of material flow in combines.	3
9.	Computation of combine losses, study of combine troubles and troubleshooting.	2
10.	Study of chaff cutters and capacity calculations.	1
11.	Study of straw combines – working principle and constructional details.	2
12.	Study of root crop diggers – principle of operation, blade adjustment and approach angle, and calculation of material handled. Study of potato and groundnut diggers.	2
13.	Study of Cotton harvesting – Cotton harvesting mechanisms, study of cotton pickers and strippers, functional components.	2
14.	Study of maize harvesting combines.	1
15.	Introduction to vegetables and fruit harvesting equipment and tools.	1
	Total	**30**
	Practicals	
S.No.	8. **Topic**	**No. of Tutorials**
1.	Familiarization with plant protection and interculture equipment.	2
2.	Study of sprayers, types, 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.	2
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.	2
6.	Familiarization with threshing systems, cleaning systems in threshers. Calculations of losses in threshers.	1
7.	Familiarization with 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.	Familiarization with the working of cotton and maize harvesters.	1
10.	Familiarization with vegetable and fruit harvesters.	1
	Total	**15**

Suggested Reading

Kepner RA, Roy Barger & EL Barger. Principles of Farm Machinery.
Smith HP and LH Wilkey. Farm Machinery and Equipment.
Culpin Claude. Farm Machinery.
Srivastava AC. Elements of Farm Machinery.
Lal Radhey and AC Datta. Agricultural Engineering.

Sr. No.	Course Name	Course No.	Credit	L	P	T
3	Post Harvest Engineering of Horticultural Crops	PFE-3.6.3	2 (1+1)	1	1	0

Course content:

Theory

Importance of processing of fruits and vegetables, spices, condiments and flowers. Characteristics and properties of horticultural crops important for processing, Peeling: Different peeling methods and devices (manual peeling, mechanical peeling, chemical peeling, and thermal peeling), Slicing of horticultural crops: equipment for slicing, shredding, crushing, chopping, juice extraction, etc., Blanching: Importance and objectives; blanching methods, effects on food (nutrition, colour, pigment, texture), Chilling and freezing: Application of refrigeration in different perishable food products, Thermophilic, mesophilic & Psychrophilic micro-organisms, Chilling requirements of different fruits and vegetables, Freezing of food, freezing time calculations, slow and fast freezing, Equipment for chilling and freezing (mechanical & cryogenic), Effect on food during chilling and freezing, Cold storage heat load calculations and cold storage design, refrigerated vehicle and cold chain system, Dryers for fruits and vegetables, Osmo-dehydration, Packaging of horticultural commodities, Packaging requirements (in terms of light transmittance, heat, moisture and gas proof, micro organisms, mechanical strength), Different types of packaging materials commonly used for raw and processed fruits and vegetables products, bulk and retail packages and packaging machines, handling and transportation of fruits and vegetables, Pack house technology, Minimal processing, Common methods of storage, Low temperature storage, evaporative cooled storage, Controlled atmospheric storage, Modified atmospheric packaging, Preservation Technology, General methods of preservation of fruits and vegetables, Brief description and advantages and disadvantages of different physical/ chemical and other methods of preservation, Flowcharts for preparation of different finished products, Important parameters and equipment used for different unit operations, Post harvest management and equipment for spices and flowers, Quality control in Fruit and vegetable processing industry. Food supply chain.

Practical

Performance evaluation of peeler and slicer, Performance evaluation of juicer and pulper, Performance evaluation of blanching equipment, Testing adequacy of blanching, Study of cold storage and its design, Study of CAP and MAP storage, Minimal processing of vegetables, Preparation of value added products, Visit to fruit and vegetable processing industry, Visit to spice processing plant

Planning of lectures

S. No.	Topics to be covered in Lecture	Proposed No. of Lectures
1	Importance of processing of fruits and vegetables, spices, condiments and flowers	1
2	Characteristics and properties of horticultural crops important for processing,	1
3	Peeling: Different peeling methods and devices (manual peeling, mechanical peeling, chemical peeling, and thermal peeling),	1
4	Slicing of horticultural crops: equipment for slicing, shredding, crushing, chopping, juice extraction, etc.,	1
5	Blanching: Importance and objectives; blanching methods, effects on food (nutrition, colour, pigment, texture),	1
6	Chilling and freezing: Application of refrigeration in different perishable food products, Thermophilic, mesophilic & Psychrophilic micro-organisms, Chilling requirements of different fruits and vegetables,	1
7	Freezing of food, freezing time calculations, slow and fast freezing, Equipment for chilling and freezing (mechanical & cryogenic), Effect on food during chilling and freezing,	1
8	Cold storage heat load calculations and cold storage design, refrigerated vehicle and cold chain system,	1
9	Dryers for fruits and vegetables, Osmo-dehydration	1
10	Packaging of horticultural commodities, Packaging requirements (in terms of	1

	light transmittance, heat, moisture and gas proof, micro organisms, mechanical strength)	
11	Different types of packaging materials commonly used for raw and processed fruits and vegetables products, bulk and retail packages and packaging machines, handling and transportation of fruits and vegetables	1
12	Pack house technology, Minimal processing, Common methods of storage, Low temperature storage, evaporative cooled storage, Controlled atmospheric storage, Modified atmospheric packaging, Preservation Technology,	1
13	General methods of preservation of fruits and vegetables, Brief description and advantages and disadvantages of different physical/ chemical and other methods of preservation,	1
14	Flowcharts for preparation of different finished products	1
15	Important parameters and equipment used for different unit operations, Post harvest management and equipment for spices and flowers,	1
16	Quality control in Fruit and vegetable processing industry. Food supply chain	1
Total		**16**

Practical

S.No.	9. **Topic**	**No. of Practical**
1	Performance evaluation of peeler	1
2	Performance evaluation of slicer	1
3	Performance evaluation of juicer	1
4	Performance evaluation of pulper	1
5	Performance evaluation of blanching equipment	1
6	Testing adequacy of blanching	1
7	Study of cold storage and its design	3
8	Study of CAP and MAP storage	1
9	Study of Minimal processing of vegetables	1
10	Preparation of value added products	3
11	Visit to fruit and vegetable processing industry	1
12	Visit to spice processing /unitplant	1
	Total	**16**

Suggested Readings

Arthey, D. and Ashurst, P. R. 1966. Fruit Processing. Chapman and Hall, New York.

Pantastico, E.C.B. 1975. Postharvest physiology, handling and utilization of tropical and subtropical fruits and vegetables AVI Pub. Co., New Delhi.

Pandey, R.H. 1997. Postharvest Technology of fruits and vegetables (Principles and practices). Saroj Prakashan, Allahabad.

Sudheer, K P. and Indira, V. 2007. Post Harvest Engineering of horticultural crops. New India Publishing House.

Girdhari Lal, G. S. Siddappa, G. L. Tandon, 1986. Preservation of Fruits and Vegetables. Indian Council of Agricultural Research

Sr. No.	Course Name	Course No.	Credit	L	P	T
4	Water Harvesting and Soil Conservation structures	SWCE-3.6.4	3 (2 + 1)	2	1	0

Course content :

Theory: Water harvesting -principles, importance and issues. Water harvesting techniques - classification based on source, storage and use. Runoff harvesting – short-term and long-term techniques. Short-term harvesting techniques - terracing and bunding, rock and ground catchments. Long-term harvesting techniques - purpose and design criteria. Structures - farm ponds - dug-out and embankment reservoir types, tanks and subsurface dykes. 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 *nala* bunds. 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. Hydraulic jump and its application. Drop spillway - applicability, types - straight drop, box-type inlet spillways - description, functional use, advantages and disadvantages, straight apron and stilling basin outlet, structural components and functions. Loads on head wall, variables affecting equivalent fluid pressure, triangular load diagram for various flow conditions, creep line theory, uplift pressure estimation, safety against sliding, overturning, crushing and tension. Chute spillway - description, components, energy dissipaters, design criteria of Saint Antony Falls (SAF) stilling basin and its limitations. Drop inlet spillway - description, functional use and design criteria.

.

Practical: Study of different types of farm ponds. Computation of storage capacity of embankment type of farm ponds. Design of dugout farm ponds. Design of percolation pond and *nala* bunds. Runoff measurement using H-flume. Exercise on hydraulic jump. Exercise on energy dissipation in water flow. Hydrologic, hydraulic and structural design of drop spillway and stability analysis. Design of SAF stilling basins in chute spillway. Hydrologic, hydraulic and structural design of drop inlet spillway. Design of small earthen embankment structures. Practice on softwares for design of soil and water conservation structures. Field visit to watershed project areas treated with soil and water conservation measures / structures.

Planning of lectures

S. No.	Topics to be covered in Lecture	Proposed No. of Lectures
1.	Water harvesting -principles, importance and issues	1
2.	Water harvesting techniques - classification based on source, storage and use	2
3.	Runoff harvesting – short-term and long-term techniques	1
4.	Short-term harvesting techniques - terracing and bunding, rock and ground catchments.	2
5.	Long-term harvesting techniques - purpose and design criteria	1
6.	Structures - farm ponds - dug-out and embankment reservoir types, tanks and subsurface dykes	2
7.	Farm pond - components, site selection, design criteria, capacity, embankment, mechanical and emergency spillways, cost estimation and construction	2
8.	Percolation pond - site selection, design and construction details	1
9.	Design considerations of *nala* bunds. Soil erosion control structures - introduction, classification and functional requirements	2
10.	Permanent structures for soil conservation and gully control - check dams, drop, chute and drop inlet spillways	3
11.	Design requirements, planning for design, design procedures - hydrologic, hydraulic and structural design and stability analysis	2
12.	Hydraulic jump and its application	1
13.	Drop spillway - applicability, types - straight drop, box-type inlet spillways -	3

	description, functional use, advantages and disadvantages, straight apron and stilling basin outlet, structural components and functions	
14.	Loads on head wall, variables affecting equivalent fluid pressure, triangular load diagram for various flow conditions	2
15.	creep line theory, uplift pressure estimation, safety against sliding, overturning, crushing and tension	2
16.	Chute spillway - description, components, energy dissipaters, design criteria of Saint Antony Falls (SAF) stilling basin and its limitations	3
17.	Drop inlet spillway - description, functional use and design criteria	2
Total		**32**

Practicals

S.No.	**10. Topic**	**No. of Practicals**
1	Study of different types of farm ponds	1
2	Computation of storage capacity of embankment type of farm ponds	1
3	Design of dugout farm ponds	1
4	Design of percolation pond and *nala* bunds	1
5	Runoff measurement using H-flume	1
6	Exercise on hydraulic jump	1
7	Exercise on energy dissipation in water flow	1
8	Hydrologic, hydraulic and structural design of drop spillway and stability analysis	2
9	Design of SAF stilling basins in chute spillway	2
10	Hydrologic, hydraulic and structural design of drop inlet spillway	2
11	Design of small earthen embankment structures	1
12	Practice on softwares for design of soil and water conservation structures	2
13	Field visit to watershed project areas treated with soil and water conservation measures / structures	1
	Total	**17**

Suggested Readings

Singh Gurmel, C. Venkataraman, G. Sastry and B.P. Joshi. 1996. Manual of Soil and Water Conservation Practices. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.

Michael, A.M. and T.P. Ojha. 2003. Principles of Agricultural Engineering. Volume II. 4th Edition, Jain Brothers, New Delhi.

Murthy, V.V.N. 2002. Land and Water Management Engineering. 4th Edition, Kalyani Publishers, New Delhi.

Schwab, G.O., D.D. Fangmeier, W.J. Elliot, R.K. Frevert. 1993. Soil and Water Conservation Engineering.4th Edition, John Wiley and Sons Inc. New York.

Suresh, R. 2014. Soil and Water Conservation Engineering. Standard Publisher Distributors, New Delhi.

Samra, J.S., V.N. Sharda and A.K. Sikka. 2002. Water Harvesting and Recycling: Indian Experiences. CSWCR&TI, Dehradun, Allied Printers, Dehradun.

Theib Y. Oweis, Dieter Prinz and Ahmed Y. Hachum. 2012. Rainwater Harvesting for Agriculture in the Dry Areas. CRC Press, Taylor and Francis Group, London.

Studer Rima Mekdaschi and Hanspeter Liniger. 2013. Water Harvesting - Guidelines to Good Practice. Centre for Development and Environment, University of Bern, Switzerland.

Sr. No	Course Name	Course No.	Credit	L	P	T
5	**Groundwater, Wells and Pumps**	**IDE-3.6.5**	**3(2+1)**	**2**	**1**	**0**

Course Content:

Theory: Occurrence and movement of ground water; aquifer and its types; classification of wells, fully penetrating tubewells and open wells, familiarization of various types of bore wells; design of open wells; groundwater exploration techniques; methods of drilling of wells: percussion, rotary, reverse rotary; design of tubewell and gravel pack, installation of well screen, completion and development of well; groundwater hydraulics-determination of aquifer parameters by different method such as Theis, Jacob and Chow's, Theis recovery method; well interference, multiple well systems, estimation of ground water potential, quality of ground water; artificial groundwater recharge techniques; pumping systems: water lifting devices; different types of pumps, classification of pumps, component parts of centrifugal pumps, priming, pump selection, installation and trouble shooting, performance curves, effect of speed on capacity, head and power, effect of change of impeller dimensions on performance characteristics; hydraulic ram, propeller pumps, mixed flow pumps and their performance characteristics; deep well turbine pump and submersible pump.

Practical : Verification of Darcy's Law; study of different drilling equipments; sieve analysis for gravel and well screens design; estimation of specific yield and specific retention; testing of well screen; estimation of aquifer parameters by Theis method, Coopers-Jacob method, Chow method; Theis Recovery method; well design under confined and unconfined conditions; well losses and well efficiency; estimating ground water balance; study of artificial ground water recharge structures; study of radial flow and mixed flow centrifugal pumps, multistage centrifugal pumps, turbine, propeller and other pumps; installation of centrifugal pump; testing of centrifugal pump and study of cavitations; study of hydraulic ram; study and testing of submersible pump.

Planning of Lecture

Sr. No	Topics to be covered in Lecture	Proposed No. of Lecture
1.	Occurrence and movement of ground water; aquifer and its types; classification of wells, fully penetrating tubewells and open wells, familiarization of various types of bore wells; design of open wells; groundwater exploration techniques; methods of drilling of wells: percussion, rotary, reverse rotary; design of tubewell and gravel pack, installation of well screen, completion and development of well	6
2.	Groundwater hydraulics-determination of aquifer parameters by different method such as Theis, Jacob and Chow's, Theis recovery method; well interference, multiple well systems, estimation of ground water potential, quality of ground water; artificial groundwater recharge techniques	6
3.	Pumping systems: water lifting devices; different types of pumps, classification of pumps, component parts of centrifugal pumps, priming	6
4.	pump selection, installation and trouble shooting	3
5.	performance curves, effect of speed on capacity, head and power, effect of change of impeller dimensions on performance characteristics	4
6.	hydraulic ram, propeller pumps, mixed flow pumps and their performance characteristics	4
7.	deep well turbine pump and submersible pump	3
	Total	**32**

Practical

Sr. No	Topics	No. of Practical
1.	Verification of Darcy's Law	1
2.	Study of different drilling equipments	1
3.	Sieve analysis for gravel and well screens design	1
4.	Estimation of specific yield and specific retention	1
5.	Testing of well screen	1

6.	Estimation of aquifer parameters by Theis method, Coopers-Jacob method, Chow method	1
7.	Theis Recovery method	1
8.	Well design under confined and unconfined conditions	1
9.	Well losses and well efficiency	1
10.	Estimating ground water balance	1
11.	Study of artificial ground water recharge structures	1
12.	Study of radial flow and mixed flow centrifugal pumps, multistage centrifugal pumps, turbine, propeller and other pumps	1
13.	Installation of centrifugal pump	1
14.	Testing of centrifugal pump and study of cavitations	1
15.	Study of hydraulic ram	1
16.	Study and testing of submersible pump.	1
17.	Estimation of different irrigation water quality parameter.	1
Total		17

Suggested Readings

Michael AM, Khepar SD. and SK Sondhi. 2008. Water Well and Pumps, 2nd Edition, Tata Mc-Graw Hill.

Todd David Keith and Larry W. Mays. 2004. Groundwater Hydrology, 3rd Edition, John Wiley & Sons, New York (International Book Distributing Company Lucknow).

Michael AM. and Ojha TP. 2014. Principles of Agricultural Engineering Vol-II, 5th Edition. Jain Brothers Publication, New Delhi.

Sr. No.	Course Name	Course No.	Credit	L	P	T
6	**Tractor and Farm Machinery Operation and Maintenance**	**FMPE-3.6.6**	**2 (0+ 2)**	**0**	**2**	**0**

Course Content:

Practical :

Familiarization with different makes and models of agricultural tractors. Identification of functional systems including fuels system, cooling system, transmission system, steering and hydraulic systems. Study of maintenance points to be checked before starting a tractor. Familiarization with controls on a tractor. Safety rules and precautions to be observed while driving a tractor. Driving practice of tractor. Practice of operating a tillage tool (mould-board plough/ disc plough) and their adjustment in the field. Study of field patterns while operating a tillage implement. Hitching & De-hitching of mounted and trail type implement to the tractor. Driving practice with a trail type trolley – forward and in reverse direction. Introduction to tractor maintenance – precautionary and break-down maintenance. Tractor starting with low battery charge. Introduction to trouble shooting in tractors. Familiarization with tools for general and special maintenance. Introduction to scheduled maintenance after 10, 100, 300, 600, 900 and 1200 hours of operation. Safety hints. Top end overhauling. Fuel saving tips. Preparing the tractor for storage. Care and maintenance procedure of agricultural machinery during operation and off-season. Repair and maintenance of implements – adjustment of functional parameters in tillage implements. Replacement of broken components in tillage implements. Replacement of furrow openers and change of blades of rotavators. Maintenance of cutter bar in a reaper. Adjustments in a thresher for different crops. Replacement of V-belts on implements. Setting of agricultural machinery workshop.

Practicals

S.No.	Topic	No. of Practicals
1.	Familiarization with different makes and models of agricultural tractors.	1
2.	Identification of functional systems including fuels system, cooling system, transmission system, steering and hydraulic systems.	4
3.	Study of maintenance points to be checked before starting a tractor.	1
4.	Familiarization with controls on a tractor. Safety rules and precautions to be observed while driving a tractor. Driving practice of tractor.	8
5.	Practice of operating a tillage tool (mould-board plough/ disc plough) and their adjustment in the field. Study of field patterns while operating a tillage implement.	3
6.	Hitching & De-hitching of mounted and trail type implement to the tractor	1
7.	Driving practice with a trail type trolley – forward and in reverse direction.	4
8.	Introduction to tractor maintenance – precautionary and break-down maintenance.	1
9.	Tractor starting with low battery charge. Introduction to trouble shooting in tractors.	1
10.	Familiarization with tools for general and special maintenance.	1
11.	Introduction to scheduled maintenance after 10, 100, 300, 600, 900 and 1200 hours of operation	1
12.	Safety hints. Top end overhauling. Fuel saving tips. Preparing the tractor for storage	1
13.	Care and maintenance procedure of agricultural machinery during operation and off-season	1
14.	Repair and maintenance of implements – adjustment of functional parameters in tillage implements. Replacement of broken components in tillage implements. Replacement of furrow openers and change of blades of rotavators.	1
15.	Maintenance of cutter bar in a reaper.	1
16.	Adjustments in a thresher for different crops, Replacement of V-belts on implements	1
17.	Setting of agricultural machinery workshop.	1
	Total	**32**

Reference Books

Ghosh RK and S Swan. Practical Agricultural Engineering.
Black PO and WE Scahill. Diesel Engine Manual.
Southorn N. Tractor operation and maintenance.
Jain SC and CR Rai. Farm Tractor Maintenance and Repair.
Operators manuals of tractors.
Service manuals provided by manufacturers.

Sr. No.	Course Name	Course No.	Credit	L	P	T
7	**Dairy and Food Engineering**	**PFE-3.6.7**	**3 (2 + 1)**	**2**	**1**	**0**

Course content :

Theory: Deterioration in food products and their controls, Physical, chemical and biological methods of food preservation. Nanotechnology: History, fundamental concepts, tools and techniques nanomaterials, applications in food packaging and products, implications, environmental impact of nanomaterials and their potential effects on global economics, regulation of nanotechnology. Dairy development in India, Engineering, thermal and chemical properties of milk and milk products, Process flow charts for product manufacture, Unit operation of various dairy and food processing systems. Principles and equipment related to receiving of milk, pasteurization, sterilization, homogenization, centrifugation and cream separation. Preparation methods and equipment for manufacture of cheese, *paneer*, butter and ice cream, Filling and packaging of milk and milk products; Dairy plant design and layout, Plant utilities; Principles of operation and equipment for thermal processing, Canning, Aseptic processing, Evaporation of food products: principle, types of evaporators, steam economy, multiple effect evaporation, vapour recompression, Drying of liquid and perishable foods: principles of drying, spray drying, drum drying, freeze drying, Filtration: principle, types of filters; Membrane separation, RO, Nano-filtration, Ultra filtration and Macro-filtration, equipment and applications, Non-thermal and other alternate thermal processing in Food processing.

Practical: Study of pasteurizers, Study of sterilizers, Study of homogenizers, Study of separators, Study of butter churns, Study of evaporators, Study of milk dryers, Study of freezers, Study of filtration, Design of food processing plants & preparation of layout, Visit to multi-product dairy plant, Estimation of steam requirements, Estimation of refrigeration requirements in dairy & food plant, Visit to Food industry.

Planning of lectures

S. No.	Topics to be covered in Lecture	Proposed No. of Lectures
1	Dairy development in India.	1
2	Engineering, thermal and chemical properties of milk and milk products.	4
3	Unit operation of various dairy and food processing systems.	2
4	Principles and equipment related to receiving of milk, pasteurization, sterilization, homogenization, centrifugation and cream separation.	4
5	Preparation methods and equipment for manufacture of cheese, *paneer*, butter and ice cream. Process flow charts for product manufacture.	3
6	Filling and packaging of milk and milk products.	2
7	Evaporation of food products: principle, types of evaporators, steam economy, multiple effect evaporation, vapour recompression.	3
8	Drying of liquid and perishable foods: principles of drying, spray drying, drum drying, freeze drying.	3
9	Filtration: principle, types of filters; Membrane separation, RO, Nano-filtration, Ultra filtration and Macro-filtration, equipment and applications.	3
10	Dairy plant design and layout, Plant utilities; Principles of operation and equipment for thermal processing, Canning, Aseptic processing, Non-thermal and other alternate thermal processing in Food processing.	3
11	Deterioration in food products and their controls, Physical, chemical and biological methods of food preservation. Nanotechnology: History, fundamental concepts, tools and techniques nanomaterials, applications in food packaging and products, implications, environmental impact of nanomaterials and their potential effects on global economics, regulation of nanotechnology.	4
Total		**32**

Practicals

S.No.	11. **Topic**	No. of Practical
1	Study of dairy development in India.	1
2	Study of homogenizers.	1

3	Study of pasteurizers.	1
4	Study of sterilizers.	1
5	Study of separators.	1
6	Study of butter churns.	1
7	Study of evaporators.	1
8	Study of milk dryers.	1
9	Study of filling equipments.	1
10	Study of freezers.	1
11	Study of filtration.	1
12	Study of equipments related to receiving of milk.	1
13	Visit to multi-product dairy plant.	1
14	Estimation of steam requirements.	1
15	Process flow chart for manufacture of cheese & paneer.	1
16	Process flow chart for preparation of butter and ice cream.	1
	Total	**16**

Suggested Readings

Ahmed, T. 1997. Dairy Plant Engineering and Management. 4th Ed. Kitab Mahal.
McCabe, W.L. and Smith, J. C. 1999. Unit Operations of Chemical Engineering. McGraw Hill.
Rao, D.G. Fundamentals of Food Engineering. PHI learning Pvt. Ltd. New Delhi.
Singh, R.P. & Heldman, D.R. 1993. Introduction to Food Engineering. Academic Press.
Toledo, R. T. 1997. Fundamentals of Food Process Engineering. CBS Publisher.
Farrel, A.W. 1963. Engineering for dairy and food products. Wiley

Sr. No.	Course Name	Course No.	Credit	L	P	T
8	**Bio-Energy Systems: Design and Applications**	**REE-3.6.8**	**3 (2+1)**	**2**	**1**	**0**

Course Content:

Fermentation processes and its general requirements, An overview of aerobic and anaerobic fermentation processes and their industrial application. Heat transfer processes in anaerobic digestion systems, land fill gas technology and potential. 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). Thermo-chemical degradation. History of small gas producer engine system. Chemistry of gasification. Gas producer – type, operating principle. Gasifier fuels, properties, preparation, conditioning of producer gas. Application, shaft power generation, thermal application and economics. Trans-esterification for biodiesel production. A range of bio-hydrogen production routes. Environmental aspect of bio-energy, assessment of greenhouse gas mitigation potential.

Practical

Study of anaerobic fermentation system for industrial application, Introduction of insulation and different types of insulation used in renewable energy gadgets, Study of gasification for industrial process heat, Study of biodiesel production unit, Study of biomass densification technique (briquetting, pelletization, and cubing), Integral bio energy system for industrial application, Study of bio energy efficiency in industry and commercial buildings, Study and demonstration of energy efficiency in building.

Planning of Lectures

S. No.	Topics to be covered in Lecture	Proposed No. of Lectures
1	Fermentation processes and its general requirements.	2
2	An overview of aerobic and anaerobic fermentation processes and their industrial application.	2
3	Heat transfer processes in anaerobic digestion systems, land fill gas technology and potential.	2
4	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.	3
5	Biomass preparation techniques for harnessing (size reduction, densification and drying).	3
6	Thermo-chemical degradation. History of small gas producer engine system. Chemistry of gasification. Gas producer – type, operating principle. Gasifier fuels, properties, preparation, conditioning of producer gas.	4
7	Application, shaft power generation, thermal application and economics.	3
8	Trans-esterification for biodiesel production.	3
9	A range of bio-hydrogen production routes.	2
10	Environmental aspect of bio-energy, assessment of greenhouse gas mitigation potential.	3
	Total	27

Planning of Practical

S.No.	Topics	Proposed No. of Practicals
1	Study of anaerobic fermentation system for industrial application,	1
2	Introduction of insulation and different types of insulation used in renewable energy gadgets	1
3	Study of gasification for industrial process heat	1
4	Study of biodiesel production unit	1
5	Study of biomass densification technique (briquetting, pelletization, and cubing)	1
6	Integral bio energy system for industrial application	1

7	Study of bio energy efficiency in industry and commercial buildings	1
8	Study and demonstration of energy efficiency in building	1
9	Study of biomass harvesting technology	1
10	Study and demonstration of heat transfer processes used in renewable energy gadgets	1
11	Study of modern greenhouse technologies	1
12	Demonstration of producer gas cooling - cleaning system	1
13	Study of shaft power generation through producer gas technology	1
14	Study of shaft power generation through fermentation process	1
15	Study of different characteristics of biodiesel.	1
16	Testing of biodiesel in diesel engine.	1
17	Study of bio-hydrogen production routes.	1
	Total	**17**

Suggested Readings

British BioGen. 1997, Anaerobic digestion of farm and food processing practices- Good practice guidelines, London, available on www.britishbiogen.co.UK.

Butler, S. 2005. Renewable Energy Academy: Training wood energy professionals.

Centre for biomass energy. 1998. Straw for energy production; Technology- Environment- Ecology. Available: www.ens.dk.

Reed TB and Das A. Handbook of Biomass Downdraft Gasifier Engine System. The Biomass Energy Foundation Press, Colorado; 1984.

SEMESTER – VII

Sr. No.	Course Name	Course No.	Credit	L	P	T
1	**10-weeks Industrial Attachment / Internship (Student READY) Registration Only**	**CAE-4.7.1**	**10 (0+10)**	**0**	**10**	**0**
8 weeks for training & 2 weeks for evaluation						

Sr. No.	Course Name	Course No.	Credit	L	P	T
2	**10-weeks Experimental Learning on campus (Student READY) Registration Only**	**CAE-4.7.2**	**10 (0+10)**	**0**	**10**	**0**
8 weeks for training & 2 weeks for evaluation						

Sr. No.	Course Name	Course No.	Credit	L	P	T
3	**Skill Development Training – II (Student READY) Registration Only**	**CAE-4.7.3**	**5 (0+5)**	**0**	**5**	**0**
At the end of 6th Semester 4 weeks for training & 1 week for evaluation						

Sr. No.	Course Name	Course No.	Credit	L	P	T
4	**Educational Tour (Registration Only)**	**CAE-4.7.4**	**2 (0+2)**	**0**	**2**	**0**
Educational tour during winter / January break						

SEMESTER – VIII

Sr. No.	Course Name	Course No.	Credit	L	P	T
1	Elective Course		3 (2+1)	2	1	0

Sr. No.	Course Name	Course No.	Credit	L	P	T
2	Elective Course		3 (2+1)	2	1	0

Sr. No.	Course Name	Course No.	Credit	L	P	T
3	Elective Course		3 (2+1)	2	1	0

Sr. No.	Course Name	Course No.	Credit	L	P	T
4	Project Planning and Report Writing (Student Ready)	**CAE-4.8.4**	10 (0+10)	0	10	0

Elective Courses (any three courses) 9 (6+3)

Sr. No.	Course Name	Course No.	Credit	L	P	T
1	**Floods and Control Measures**	**SWCE-4.8.1**	**3 (2 + 1)**	**2**	**1**	**0**

Course content :

Theory:

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 - log normal, 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. Ravine control measures. River training works, planning of flood control projects and their economics. 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. Subsurface dams - site selection and constructional features. Check dam - Small earthen embankments - types and design criteria. Subsurface dams - site selection and constructional features.

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. Design of jetties. Study of vegetative and structural measures for gully stabilization. Design of gully/ravine control structures and cost estimation. Designing, planning and cost- benefit analysis of a flood control project. Study of different types, materials and design considerations 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 etc. 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. Visit to sites of earthen dam and water harvesting structures.

Planning of lectures

S. 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, flood estimation	2
2	methods of estimation; estimation of flood peak - rational method, empirical methods, unit hydrograph method	2
3	Statistics in hydrology, flood frequency methods - log normal, Gumbel's extreme value, log-Pearson type-III distribution; depth-area-duration analysis	2
4	Flood forecasting	1
5	Flood routing - channel routing, Muskingum method,	2
6	reservoir routing, modified Pul's method	2
7	Flood control - history of flood control, structural and non-structural measures of flood control	1
8	storage and detention reservoirs, levees, channel improvement	1
9	Gully erosion and its control structures - design and implementation	1
10	Ravine control measures	1
11	River training works, planning of flood control projects and their economics	2

12	Earthen embankments - functions, classification - hydraulic fill and rolled fill dams - homogeneous, zoned and diaphragm type, foundation requirements, grouting	3
13	seepage through dams, flow net and its properties, seepage pressure, seepage line in composite earth embankments, drainage filters, piping and its causes	2
14	Design and construction of earthen dam, stability of earthen embankments against failure by tension, overturning, sliding etc.	2
15	stability of slopes - analysis of failure by different methods	2
16	Subsurface dams - site selection and constructional features	2
17	Check dam - Small earthen embankments - types and design criteria	2
18	Subsurface dams - site selection and constructional features	2
Total		**32**

Practicals

S.No.	12. **Topic**	**No. of Practicals**
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, Design of jetties	1
8.	Study of vegetative and structural measures for gully stabilization, Design of gully/ravine control structures and cost estimation	1
9.	Designing, planning and cost- benefit analysis of a flood control project	1
10.	Study of different types, materials and design considerations of earthen dams	1
11.	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 etc	1
12.	Stability of slopes of earth dams by friction circle and other methods	1
13.	Construction of flow net for isotropic and anisotropic media	1
14.	Computation of seepage by different methods	1
15.	Determination of settlement of earth dam	1
16.	Input-output-storage relationships by reservoir routing	1
17.	Visit to sites of earthen dam and water harvesting structures	1
	Total	**17**

Suggested Readings

Michael, A.M. and T.P. Ojha. 2003. Principles of Agricultural Engineering. Volume II. 4th Edition, Jain Brothers, New Delhi.

Murthy, V.V.N. 2002. Land and Water Management Engineering. 4th Edition, Kalyani Publishers, New Delhi.

Suresh, R. 2014. Soil and Water Conservation Engineering. Standard Publisher Distributors, New Delhi.

Mutreja, K.N. 1990. Applied Hydrology. Tata McGraw-Hill Publishing Co., New York, Delhi.

Subramanya, K. 2008. Engineering Hydrology. 3rd Edition, Tata McGraw-Hill Publishing Co., New Delhi.

Bureau of Reclamation. 1987. Design of Small Dams. US Department of Interior, Washington DC, USA.

Arora, K.R. 2014. Soil Mechanics and Foundation Engineering (Geotechnical Engineering). Standard Publishers Distributors, Delhi.

Garg, S.K. 2014. Soil Mechanics and Foundation Engineering. Khanna Publishers Pvt. Ltd., New Delhi.

Stephens Tim. 2010. Manual on Small Earth Dams - A Guide to Siting, Design and Construction. Food and Agriculture Organization of the United Nations, Rome.

Sr. No.	Course Name	Course No.	Credit	L	P	T
2	**Wasteland Development**	**SWCE-4.8.2**	**3 (2 + 1)**	**2**	**1**	**0**

Course content :

Theory: Land degradation – concept, classification - arid, semiarid, humid and sub-humid regions, denuded range land and marginal lands. Wastelands - factors causing, classification and mapping of wastelands, planning of wastelands 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. Government policies. Participatory approach. 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. Cost estimation of the above measures / structures. Visit to wasteland development project sites.

Planning of lectures

S. 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.	Land degradation – denuded range land and marginal lands	2
3.	Wastelands - factors causing, classification and mapping of wastelands	2
4.	planning of wastelands development - constraints, agro-climatic conditions, development options, contingency plans	2
5.	Conservation structures - gully stabilization, ravine rehabilitation, sand dune stabilization	2
6.	Conservation structures - 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	2
10.	Wasteland development – reclamation of waterlogged and salt-affected lands	2
11.	Mine spoils- impact, land degradation and reclamation and rehabilitation	2
12.	Mine spoils- slope stabilization and mine environment management	2
13.	Micro-irrigation in wastelands development	2
14.	Sustainable wasteland development - drought situations, socio-economic perspectives	2
15.	Government policies, Participatory approach	2
16.	Preparation of proposal for wasteland development and benefit-cost analysis	2
Total		**32**

Practicals

S.No.	13. Topic	No. of

		Practicals
1.	Mapping and classification of wastelands	2
2.	Identification of factors causing wastelands	2
3.	Estimation of vegetation density and classification	2
4.	Planning and design of engineering measures for reclamation of wastelands	3
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	2
7.	Cost estimation of the above measures / structures	2
8.	Visit to wasteland development project sites	2
	Total	**17**

Suggested Readings

Abrol, I.P., and V.V. Dhruvanarayana. 1998. Technologies for Wasteland Development. ICAR, New Delhi.

Ambast, S.K., S.K. Gupta and Gurcharan Singh (Eds.) 2007. Agricultural Land Drainage - Reclamation of Waterlogged Saline Lands. Central Soil Salinity Research Institute, Karnal, Haryana.

Hridai Ram Yadav. 2013. Management of Wastelands. Concept Publishing Company. New Delhi.

Karthikeyan, C., K. Thangaraja, C. Cinthia Fernandez and K. Chandrakandon. 2009. Dryland Agriculture and Wasteland Management. Atlantic Publishers and Distributors Pvt. Ltd., New Delhi.

Rattan Lal and B.A. Stewart (Ed.). 2015. Soil Management of Smallholder Agriculture. Volume 21 of Advances in Soil Science. CRC Press, Taylor and Francis Group, Florida, USA.

Robert Malliva and Thomas Missimer. 2012. Arid Lands Water Evaluation and Management. Springer Heidelberg, New York.

Swaminathan, M.S. 2010. Science and Integrated Rural Development. Concept Publishing Company (P) Ltd., Delhi.

The Energy and Resources Institute. 2003. Looking Back to Think Ahead-Green India 2047. Growth with Resource Enhancement of Environment and Nature. New Delhi.

Virmani, S.M. (Ed.). 2010. Degraded and Wastelands of India: Status and Spatial Distribution. ICAR, New Delhi**.**

Sr. No.	Course Name	Course No.	Credit	L	P	T
3	Information Technology for Land and Water Management	SWCE-4.8.3	3 (2 + 1)	2	1	0

Course content :

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 programmes. 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 programmes. 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.

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	2
2.	Role of IT in natural resources management	2
3.	Existing system of information generation and organizations involved in the field of land and water management	2
4.	Application and production of multimedia	2
5.	Internet application tools and web technology	2
6.	Networking system of information	2
7.	Problems and prospects of new information and communication technology	2
8.	Development of database concept for effective natural resources management	2
9.	Application of remote sensing, geographic information system (GIS) and GPS	4
10.	Rational data base management system, Object oriented approaches,	2
11.	Information system, decision support systems and expert systems	2
12.	Agricultural information management systems - use of mathematical models and programmes	3
13.	Application of decision support systems, multi sensor data loggers and overview of software packages in natural resource management	3
14.	. Video-conferencing of scientific information.	2
Total		**32**

Practicals

S.No.	14. **Topic**	No. of Practicals
1.	Multimedia production. Internet applications: E-mail, voice mail, web tools and technologies	2

2.	Handling and maintenance of new information technologies and exploiting their potentials	2
3.	Exercises on database management using database and spreadsheet programmes	2
4.	Usage of remote sensing, GIS and GPS survey in information generation and processing	2
5.	Exercises on running computer software packages dealing with water balance, crop production, land development, land and water allocation, watershed analysis etc	2
6.	Exercises on simple decision support and expert systems for management of natural resources	2
7.	Multimedia production using different softwares	2
8.	Exercises on development of information system on selected theme(s)	2
9.	Video-conferencing of scientific information	1
	Total	**17**

Suggested Readings

Climate-Smart Agriculture – Source Book. 2013. Food and Agriculture Organization, Rome.

Daniel P. Loucks and Eelco van Beek. 2005. Water Resources Systems Planning and Management - An Introduction to Methods, Models and Applications. UNESCO, Paris.

Dipak De and Basavaprabhu Jirli (Eds.). 2010. Communication Support for Sustainable Development. Ganga Kaveri Publishing House, Varanasi – 221001.

FAO. 1998. Land and Water Resources Information Systems. FAO Land and Water Bulletin 7, Rome.

Fuling Bian and Yichun Xie (Eds.). 2015. Geo-Informatics in Resource Management and Sustainable Ecosystem. Springer, New York.

ICFAI Business School (IBS). 2012. Information Technology and Systems. IBS Centre for Management Research, Hyderabad.

Robert Malliva and Thomas Missimer. 2012. Arid Lands Water Evaluation and Management. Environmental Science. Springer, New York.

Sarvanan. R. 2011. Information and Communication Technology for Agriculture and Rural Development. New India Publishing Agency, New Delhi.

Soam, S.K., P.D. Sreekanth and N.H. Rao (Eds.). 2013. Geospatial Technologies for Natural Resources Management. New India Publishing Agency, Delhi**.**

Sr. No.	Course Name	Course No.	Credit	L	P	T
4	Remote Sensing and GIS Applications	SWCE-4.8.4	3 (2 + 1)	2	1	0

Course content :

Theory: 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 measurements 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. GI Sand 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	2
2.	possible use of RS techniques in assessment and monitoring of land and water resources	2
3.	electromagnetic spectrum, energy interactions in the atmosphere and with the Earth's surface; major atmospheric windows	2
4.	principal applications of different wavelength regions	1
5.	typical spectral reflectance curve for vegetation, soil and water; spectral signatures	2
6.	different types of sensors and platforms, contrast ratio and possible causes of low contrast	2
7.	aerial photography; types of aerial photographs, scale of aerial photographs	2
8.	planning aerial photography- end lap and side lap	1
9.	stereoscopic vision, requirements of stereoscopic photographs	1
10.	air-photo interpretation- interpretation elements; photogrammetry- measurements on a single vertical aerial photograph	2
11.	measurements on a stereo-pair- vertical measurements by the parallax method; ground control for aerial photography	2
12.	satellite remote sensing, multispectral scanner- whiskbroom and push-broom scanner; different types of resolutions	2
13.	analysis of digital data- image restoration; image enhancement; information extraction, image classification, unsupervised classification, supervised	2

	classification	
14.	important consideration in the identification of training areas, vegetation indices;	2
15.	microwave remote sensing. GIS and basic components,	1
16.	different sources of spatial data, basic spatial entities, major components of spatial data	1
17.	Basic classes of map projections and their properties,	1
18.	Methods of data input into GIS, Data editing, spatial data models and structures,	1
19.	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	2
Total		**32**

Practicals

S.No.	**15. Topic**	**No. of Practicals**
1.	Familiarization with remote sensing and GIS hardware;	1
2.	use of software for image interpretation	2
3.	Interpretation of aerial photographs and satellite imagery;	2
4.	Basic GIS operations such as image display;	2
5.	Study the various features of GIS software package;	3
6.	Scanning, digitization of maps and data editing	2
7.	Data base query and map algebra;	2
8.	GIS supported case studies in water resources management.	3
	Total	**17**

Suggested Readings

Reddy Anji, M. 2006. Textbook of Remote Sensing and Geographical Information Systems. BS Publications, Hyderabad.

Elangovan, K. 2006. GIS Fundamentals Applications and Implementations. New India Publication Agency, New Delhi.

George Joseph. 2005. Fundamentals of Remote Sensing. 2nd Edition. Universities Press (India) Private Limited, Hyderabad.

Jensen, J.R. 2013. Remote Sensing of the Environment: An Earth Resource Perspective. Pearson Education Limited, UK.

Lillesand, T., R.W. Kiefer and J. Chipman. 2015. Remote Sensing and Image Interpretation. 7th Edition, John Wiley and Sons Singapore Pvt. Ltd., Singapore.

Sabins, F.F. 2007. Remote Sensing: Principles and Interpretation. Third Edition, Waveland Press Inc., Illinois, USA.

Sahu, K.C. 2008. Text Book of Remote Sensing and Geographic Information Systems. Atlantic Publishers and Distributors (P) Ltd., New Delhi.

Shultz, G.A. and E.T. Engman. 2000. Remote Sensing in Hydrology and Water Management. Springer, New York

Sr. No	Course Name	Course No.	Credit	L	P	T
5	Management of Canal Irrigation System	IDE-4.8.5	3(2+1)	2	1	0

Course Content:

Theory: Purpose benefits and ill effects of irrigation; typical network of canal irrigation system and its different physical components; canal classification based on source of water, financial output, purpose, discharge and alignment; canal alignment: general considerations for alignment; performance indicators for canal irrigation system evaluation, Estimation of water requirements for canal command areas and determination of canal capacity; water duty and delta, relationship between duty, base period and delta, factors affecting duty and method of improving 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 warabandhi, 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; sources of surplus water in canals and types of canal escapes; requirements of a good canal outlet and types of outlet.

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, full banking and partial cutting and partial banking; determination of longitudinal section of canals; design of irrigation canals based on silt theories; design of lined canals; formulation of warabandhi; Study of canal outlets, regulators, escapes and canal falls.

Planning of Lecture

Sr. No	Topics to be covered in Lecture	Proposed No. of Lecture
1	Purpose benefits and ill effects of irrigation; typical network of canal irrigation system and its different physical components; canal classification based on source of water, financial output, purpose, discharge and alignment	6
2	Canal alignment: general considerations for alignment; performance indicators for canal irrigation system evaluation	4
3	Estimation of water requirements for canal command areas and determination of canal capacity; water duty and delta, relationship between duty, base period and delta, factors affecting duty and method of improving duty	6
4	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
5	Maintenance of unlined irrigation canals, measurement of discharge in canals, rostering (canal running schedule) and warabandhi, necessity of canal lining: advantages and disadvantages,	4
6	Types of canal lining and desirable characteristics for the suitability of lining materials; design of lined canals; functions of distributary head and cross regulators	4
7	Canal falls, their necessity and factors affecting canal fall; sources of surplus water in canals and types of canal escapes; requirements of a good canal outlet and types of outlet.	4
	Total	**32**

Practicals

Sr. No	Topics	No. of Practicals
1	Determination of canal capacity	2
2	Layout of canal alignments on topographic maps, drawing of canal sections in cutting, full banking and partial cutting and partial banking;	3
3	Determination of longitudinal section of canals;	2
4	Design of irrigation canals based on silt theories;	2
5	Design of lined canals;	3

6	Formulation of warabandhi;	2
7	Study of canal outlets, regulators, escapes and canal falls.	2
	Total	**16**

Suggested Readings

Arora, K.R. 2001. Irrigation, Water Power and Water Resources Engineering. Standard Publishers Distributors, Delhi.

Garg S. K. 2014. Irrigation Engineering and Hydraulic Structures, Khanna Publishers New Delhi.

Sahasrabudhe SR. 2011. Irrigation Engineering and Hydraulic structures. SK Kataria & Sons Reprint 2015.

Sr. No	Course Name	Course No.	Credit	L	P	T
6	**Minor Irrigation and Command Area Development**	**IDE-404**	**3(2+1)**	**2**	**1**	**0**

Course Content:

Theory: Factors affecting performance of irrigation projects; types of minor irrigation systems in India; 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; command area development (CAD) programme- components, need, scope, and development approaches, historical perspective, command area development authorities-functions and responsibilities; on farm development works, reclamation works, use of remote sensing techniques for CAD works; water productivity: concepts and measures for enhancing water productivity; Farmers' participation in command area development;

Practical : Preparation of command area development layout plan; Irrigation water requirement of crops; 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 of Lecture

Sr. No	Topics to be covered in Lecture	No. of Lecture
1	Factors affecting performance of irrigation projects	3
2	Types of minor irrigation systems in India	2
3	Lift irrigation systems: feasibility, type of pumping stations and their site selection, design of lift irrigation systems	5
4	Tank Irrigation: grouping of tanks, storage capacity, supply works and sluices	4
5	Command area development (CAD) programme- components, need, scope, and development approaches, historical perspective, command area development authorities-functions and responsibilities	4
6	On farm development works, reclamation works	4
7	Use of remote sensing techniques for CAD works	4
8	Water productivity: concepts and measures for enhancing water productivity	4
9	Farmers' participation in command area development	2
	Total	**32**

Practical

Sr. No	Topics	No. of Practical
1	Preparation of command area development layout plan	4
2	Irrigation water requirement of crops	2
3	Preparation of irrigation schedules	2
4	Planning and layout of water conveyance system	2
5	Design of surplus weir of tanks	2
6	Determination of storage capacity of tanks	2
7	Design of intake pipe and pump house.	2
	Total	**16**

Suggested Readings

Arora, K.R. 2001. Irrigation, Water Power and Water Resources Engineering. Standard Publishers Distributors, Delhi.

Garg S. K. 2014. Irrigation Engineering and Hydraulic Structures, Khanna Publishers New Delhi.

Michael A.M. 2012. Irrigation: Theory and Practice. Vikas Publishing Vikas Publ.House New Delhi.

Sahasrabudhe SR. 2011. Irrigation Engineering and Hydraulic structures. SK Kataria & Sons Reprint 2015.

Sr. No	Course Name	Course No.	Credit	L	P	T

7	**Precision Farming Techniques for Protected Cultivation**	**IDE-4.8.7**	**3(2+1)**	**2**	**1**	**0**

Course Content:

Theory: Protected cultivation: Introduction, History, origin, development, National and International Scenario, components of green house, perspective, Types of green houses, polyhouses /shed nets, 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 green houses – site selection, orientation, design, construction, design for ventilation requirement using exhaust fan system, selection of equipment, Greenhouse cooling system – necessity, methods – ventilation with roof and side ventilators, evaporative cooling, different shading material fogging, combined fogging and fan-pad cooling system, design of cooling system, maintenance of cooling and ventilation systems, pad care etc. Greenhouse heating – necessity, components, methods, design of heating system. Root media – types – soil and soil less 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 ; Greenhouse heating; 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 Lecture

Sr. No	Topics to be covered in Lecture	Proposed No. of Lecture
1	Protected cultivation: Introduction, History, origin, development, National and International Scenario, components of green house, perspective	2
2	Types of green houses, polyhouses /shed nets, Cladding materials	1
3	Plant environment interactions – principles of limiting factors, solar radiation and transpiration, greenhouse effect, light, temperature, relative humidity, carbon dioxide enrichment	3
4	Design and construction of green houses – site selection, orientation, design, construction, design for ventilation requirement using exhaust fan system, selection of equipment	3
5	Greenhouse cooling system – necessity, methods – ventilation with roof and side ventilators, evaporative cooling, different shading material fogging, combined fogging and fan-pad cooling system, design of cooling system, maintenance of cooling and ventilation systems, pad care etc.	4
6	Greenhouse heating – necessity, components, methods, design of heating system.	2
7	Root media – types – soil and soil less media, composition, estimation, preparation and disinfection, bed preparation. Planting techniques in green house cultivation.	3
8	Fogging system for greenhouses and net houses – introduction, benefits, design,	3

	installation and material requirement. Maintenance of irrigation and fogging systems.	
9	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
10	Greenhouse climate measurement, control and management. Insect and disease management in greenhouse and net houses	3
11	Selection of crops for greenhouse cultivation, major crops in greenhouse – irrigation requirement, fertilizer management, cultivation, harvesting and post harvest techniques; Economic analysis.	4
	Total	**32**

Practical

Sr. No	**Topics**	**No. of Practical**
1	Estimation of material requirement for construction of greenhouse ;	3
2	Determination of fertilization schedule and rate of application for various crops;	1
3	Estimation of material requirement for preparation of root media	1
4	Root media preparation, bed preparation and disinfections;	1
5	Study of different planting techniques ;	1
6	Design and installation of irrigation system;	1
7	Design and installation of fogging system ;	1
8	Greenhouse heating;	1
9	Study of different greenhouse environment control instruments;	1
10	Study of operation maintenance and fault detection in irrigation system;	1
11	Study of operation maintenance and fault detection in fogging system;	1
12	Economic analysis of greenhouses and net houses;	2
13	Visit to greenhouses.	1
	Total	**16**

Suggested Readings

Singh Brahma and Balraj Singh. 2014. Advances in protected cultivation, New India Publishing Company.

Sharma P. 2007. Precision Farming. Daya Publishing House New Delhi.

Sr. No.	Course Name	Course No.	Credit	L	P	T
8	**Water Quality and Management Measures**	**IDE-4.8.8**	**3 (2 + 1)**	**2**	**1**	**0**

Course content :

Theory:

Natural factors affecting quality of surface water and groundwater, water quality objectives in relation to domestic, industrial and agricultural activities, drinking water quality standards, irrigation water quality classification as per USSL and All Indian Coordinated Research Project (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 contamination movement and transport in soil profile; study of different water decontamination techniques; study of different cultural and management practices for using poor quality water for irrigation; field visit to industrial effluent disposal sites.

Planning of lectures

S. No.	Topics to be covered in Lecture	No. of Lectures
1	Natural factors affecting quality of surface water and groundwater	3
2	Water quality objectives in relation to domestic, industrial and agricultural activities	4
3	Drinking water quality standards, irrigation water quality classification as per USSL and All Indian Coordinated Research Project (AICRP) criteria	4
4	Point and non-point water pollution sources	3
5	Water contamination due to inorganic and organic compounds	3
6	Water contamination related to agricultural chemicals, food industry, hydrocarbon and synthetic organic compounds	3
7	Arsenic and fluoride contamination in groundwater and remedial measures	4
8	Water decontamination technologies	4
9	Cultural and management practices for using poor quality water for irrigation	4
	Total	**32**

Practicals

S.No.	16. **Topic**	No. of Practicals
1	Water quality analysis and classification according to USSL and AICRP criteria	3
2	Soil chemical analysis and estimation of lime and gypsum requirements	2
3	Study of salinity development under shallow and deep water table conditions	3
4	Study of contamination movement and transport in soil profile	2
5	Study of different water decontamination techniques	3
6	Study of different cultural and management practices for using poor quality water for irrigation	2
	Total	**17**

Suggested Readings

FAO. 1996. Control of water pollution from agriculture - FAO irrigation and drainage paper 55.Gray, N.F. Water Technology. Raj Kamal Electric Press, Kundli, Haryana.Hussain, S.K. 1986. Text Book of Water Supply and Sanitary Engineering. Oxford & IBH Publishing Co. New Delhi.Manahan, S.E. 2009. Fundamentals of Environmental Chemistry. CRC Press, New York.McGauhey, P.H. 1968. Engineering Management of water quality. McGraw Hill Book Company, New York.Minhas, P.S. and Tyagi, N.K. 1998. Guidelines for irrigation with saline and alkali waters.

Bull. No, 1/98, CSSRI, Karnal, p. :36.Punmia, B.C. and Lal, P.B.B. 1981. Irrigation and water power engineering. Standard Publishers Distributors, Delhi.

Sr. No	Course Name	Course No.	Credit	L	P	T
9	**Landscape Irrigation Design and Management**	**IDE-4.8.9**	**3(2+1)**	**2**	**1**	**0**

Course Content:

Theory: Conventional method of landscape irrigation- hose irrigation system, quick release coupling 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, Design of modern landscape irrigation systems, operation and maintenance of landscape irrigation systems.

Practical: Study of irrigation equipments 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 equipments, Use of AutoCAD in irrigation design: blocks & symbols, head layout, zoning and valves layout, pipe sizing, Pressure calculations etc., Visit to landscape irrigation system and its evaluation.

Planning of Lecture

Sr. No	Topics to be covered in Lecture	No. of Lecture
1.	Conventional method of landscape irrigation- hose irrigation system, quick release coupling system and portable sprinkler with hose pipes	4
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	3
4.	Types of landscapes and suitability of different irrigation methods, water requirement for different landscapes, Segments of landscape irrigation systems,	5
5.	Main components of modern landscape irrigation systems and their selection criteria; Types of pipes, pressure ratings, sizing and selection criteria;	6
6.	Automation system for landscape irrigation- main components, types of controllers and their application,	4
7.	Design of modern landscape irrigation systems, operation and maintenance of landscape irrigation systems.	5
	Total	**32**

Practical

Sr. No	Topics	No. of Practical
1.	Study of irrigation equipments for landscapes;	2
2.	Design and installation of irrigation system for landscape, determination of water requirement.	3
3.	Determination of power requirement, pump selection.	2
4.	Irrigation scheduling of landscapes, Study of irrigation controllers and other equipments,	3
5.	Use of AutoCAD in irrigation design: blocks & symbols, head layout, zoning and valves layout, pipe sizing, Pressure calculations etc.,.	4
6.	Visit to landscape irrigation system and its evaluation	2
	Total	**16**

Suggested Readings

Michael A.M. 2012. Irrigation: Theory and Practice. Vikas Publishing Vikas Publ. House New Delhi.
Singh Neeraj Partap. 2010. Landscape Irrigation and Floriculture Terminology, Bangalore.
Smith Stepehen W. Landscape Irrigation and Management. John Wiley and Sons.

Sr. No.	Course Name	Course No.	Credit	L	P	T
10	**Plastic Applications in Agriculture**	**REE-4.8.10**	**3 (2+1)**	**2**	**1**	**0**

Course Content:

Introduction of protected cultivation and plasticulture - types and quality of plastics used in soil and water conservation, production agriculture and post harvest management. Quality control measures. Present status and future prospective of plasticulture in India. 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. 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 plasticutlure 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 covers for food grain storage, innovative packaging solutions - leno bags, crates, bins, boxes, vacuum packing, unit packaging, CAS and MAP and estimation. 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/ polyhouse/shadehouse/ nethouse etc. Visits to farmers' fields with these installations.

Planning of Lectures

S. No.	Topics to be covered in Lecture	Proposed No. of Lectures
1	Introduction of protected cultivation and plasticulture - types and quality of plastics used in soil and water conservation, production agriculture and post harvest management.	2
2	Quality control measures. Present status and future prospective of plasticulture in India.	3
3	Water management - use of plastics in in-situ moisture conservation and rain water harvesting.	3
4	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	3
5	Use of polymers in control of percolation losses in fields. Soil conditioning - soil solarisation, effects of different colour plastic mulching in surface covered cultivation	3
6	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
7	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.	3
8	Plastic cap covers for storage of food grains in open. Use of plastics as alternate material for manufacturing farm equipment and machinery.	3
9	Plastics for aquacultural engineering and animal husbandry - animal shelters, vermi-beds	3

	and inland fisheries. Silage film technique for fodder preservation.	
10	Agencies involved in the promotion of plasticulture in agriculture at national and state level. Human resource development in plasticutlure applications.	3
	Total	**30**

Planning of Practical

S.No.	Topics	Proposed No. of Practicals
1	Study of solar greenhouse for agriculture production	1
2	Design, estimation and laying of plastic films in lining of canal, reservoir and water harvesting ponds	1
3	Study of plastic components of drip and sprinkler irrigation systems, laying and flushing of laterals. Study of components of subsurface drainage system.	2
4	Study of different colour plastic mulch laying. Design, estimation and installation of green, poly and shade net houses, low tunnels etc	1
5	Study on cap covers for food grain storage, innovative packaging solutions - leno bags, crates, bins, boxes, vacuum packing, unit packaging, CAS and MAP and estimation	2
6	Study on use of plastics in nursery, plant protection, inland fisheries, animal shelters, preparation of vermi-bed and silage film for fodder preservation.	1
7	Study of plastic parts in making farm machinery.	1
8	Visits to nearby manufacturing units/dealers of PVC pipes, drip and sprinkler irrigation systems, greenhouse/ polyhouse/shadehouse/ nethouse etc.	1
9	Visits to farmers' fields with these installations.	1
	Total	**11**

Suggested Readings

Brahma Singh, Balraj Singh, Naved Sabir and Murtaza Hasan. 2014. Advances in Protected Cultivation. New India Publishing Agency, New Delhi.

Brown, R.P. 2004. Polymers in Agriculture and Horticulture. RAPRA Review Reports : Vol. 15, No. 2, RAPRA Technology Limited, U.K.

Central Pollution Control Board. 2012. Material on Plastic Waste Management. Parivesh Bhawan, East Arjun Nagar, Delhi-110032.

Charles A. Harper. 2006. Handbook of Plastics Technologies. The Complete Guide to Properties and Performance. McGraw-Hill, New Delhi.

Dubois. 1978. Plastics in Agriculture. Applied Science Publishers Limited, Essex, England.

Manas Chanda, Salil K. Roy. 2008. Plastics Fundamentals, Properties, and Testing. CRC Press.

Ojha,T.P. and Michael, A.M., 2012, Principles of Agricultural Engineering - I. Jain Brothers, Karol Bagh, New Delhi.

Pandey, P.H. 2014. Principles and Practices of Agricultural Structures and Environmental Control. Kalyani Publishers, Ludhiana, India.

Shankar, A.N. 2014. Integrated Horticulture Development in Eastern Himalayas, Plasticulture in Agri-Horticulture Systems, 241-247.

Srivastava, R.K., R.C. Maheswari, T.P. Ojha, and A. Alam. 1988. Plastics in Agriculture. Jain Brothers, Karol Bagh, New Delhi.

Sr.No.	Course Name	Course No.	Credit	L	P	T
11	**Mechanics of Tillage and Traction**	**FMPE - 402**	**3(2+1)**	**2**	**1**	**0**

Course Content:

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, tyre size, tyre lug geometry and their effects, tyre testing, soil compaction and plant growth, variability and 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.

Sr. No.	Topic of course	Proposed No. of Lectures
1	Introduction to mechanics of tillage tools	2
2	Engineering properties of soil,	2
3	Principles and concepts	2
4	Stress strain relationship	2
5	Design of tillage tools, principles of soil cutting	2
6	Design equation	2
7	Force analysis	2
8	Application of dimensional analysis in soil dynamics and traction prediction equation	2
9	Introduction to traction and mechanics	2
10	Off road traction and mobility	2
11	Traction model	2
12	Traction improvement,	2
13	Tyre size, tyre lug geometry and their effects	2
14	Tyre testing	2
15	Soil compaction and plant growth	2
16	Variability and application of GIS in soil dynamics	2
	Total	**32**

Practicals

Sr. No.	Topic	No. of Practicals
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 shrinkage under dry and wet soil conditions and load and fuel consumption for different farm operations	2
5	Weight transfer and tractor loading including placement and traction aids	2
6	Studies on tyres	2
7	Tracks and treads under different conditions,	2
8	Soil compaction and number of operations	2
	Total	**16**

Suggested Readings:

Vandenberg and Gill. Tillage and Traction.
Liljedahl JB and others. Tractor and Power Units.
Daniel Hill. Fundamentals of Soil Physics.
Terzaghi K & Peck Ralph B. Soil Mechanics in Engineering Practices.

Sr. No.	Course Name	Course No.	Credit	L	P	T
12	**Farm Machinery Design and Production**	**FMPE-4.8.12**	**3(2+1)**	**2**	**1**	**0**

Course Content:

Theory: Introduction to design parameters of agricultural machines & design procedure. Characteristics of farm machinery design. Research and development aspects of farm machinery. Design of standard power transmission components used in agricultural machines: mechanical & hydraulic units. Introduction to safety in power transmission. Application of design principles to the systems of selected farm machines. Critical appraisal in production of Agricultural Machinery; Advances in material used for agricultural machinery. Cutting tools including CNC tools and finishing tools. Advanced manufacturing techniques including powder metallurgy, EDM (Electro-Discharge Machining), Heat Treatment of steels including pack carburizing, shot pining process, etc. Limits, Fits & Tolerances, Jigs & 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 & equipment Visit to Agricultural machinery manufacturing industry, Tractor manufacturing industry Jigs and Fixtures – study in relation to agricultural machinery. 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.

Sr. No.	Topic of course	No. of Lectures
1	Introduction to design parameters of agricultural machines & design procedure	2
2	Characteristics of farm machinery design	2
3	Research and development aspects of farm machinery	2
4	Design of standard power transmission components used in agricultural machines: mechanical & hydraulic units.	2
5	Introduction to safety in power transmission	2
6	Application of design principles to the systems of selected farm machines	2
7	Critical appraisal in production of Agricultural Machinery; Advances in material used for agricultural machinery	2
8	Cutting tools including CNC tools and finishing tools	2
9	Advanced manufacturing techniques including powder metallurgy	2
10	EDM (Electro-Discharge Machining)	2
11	Heat Treatment of steels including pack carburizing, shot pining process, etc	2
12	Limits, Fits & Tolerances	2
13	Jigs & Fixtures	2
14	Industrial lay-out planning	2
15	Quality production management	2
16	Reliability. Economics of process selection. Familiarization with Project Report	2
	Total	**32**

Practicals

Sr. No.	Topic	No. of Practicals
1	Familiarization with different design aspects of farm machinery and selected components	2
2	Solving design problems on farm machines & equipment	2
3	Visit to Agricultural machinery manufacturing industry	2
4	Tractor manufacturing industry Jigs and Fixtures – study in relation to agricultural machinery	2
5	Fits, tolerances and limits	2
6	Layout planning of a small scale industry	2
7	Problems on Economics of process selection	2
8	Preparation of a project report	1
9	Case study for manufacturing of simple agricultural machinery.	1
	Total	**16**

Suggested Readings:

Richey, C.B. Agricultural Engineering Handbook.
Adinath M and AB Gupta. Manufacturing Technology.
Sharma PC and DK Aggarwal. Machine Design.
Narula V. Manufacturing process.
Singh S. Mechanical Engineer's Handbook.
Chakrabarti NR. Data book for Machine Design.

Sr. No.	Course Name	Course No.	Credit	L	P	T
13	Human Engineering and Safety	FMPE-4.8.13	3 (2 + 1)	2	1	3

Course content :

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 and factual 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, heat exchange process and performance, air pollution. Dangerous machine (Regulation) act, Rehabilitation and compensation to accident victims, Safety gadgets for spraying, threshing, Chaff cutting and tractor & 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, Familiarization with electro-myograph equipment, anthropometric measurements of a selected subjects. 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.

Planning of lectures

S. No.	Topics to be covered in Lecture	Proposed No. of Lectures
1	Human factors in system development – concept of systems; basic processes in system development, performance reliability, human performance.	4
2	Information input process, visual displays, major types and use of displays, auditory and factual displays. Speech communications.	4
3	Biomechanics of motion, types of movements, Range of movements, strength and endurance, speed and accuracy, human control of systems.	4
4	Human motor activities, controls, tools and related devices.	3
5	Anthropometry: arrangement and utilization of work space,	4
6	Atmospheric conditions, heat exchange process and performance, air pollution.	3
7	Dangerous machine (Regulation) act,	3
8	Rehabilitation and compensation to accident victims,	3
9	Safety gadgets for spraying, threshing, Chaff cutting and tractor & trailer operation etc.	4
	Total	**32**

Practicals

S. No.	Topic	No. of Practicals
1.	Calibration of the subject in the laboratory using bi-cycle ergo-meter.	2
2.	Study and calibration of the subject in the laboratory using mechanical treadmill.	2
3.	Use of respiration gas meter from human energy point of view.	2
4.	Use of Heart Rate Monitor.	1
5.	Study of general fatigue of the subject using Blink ratio method,	1
6.	Familiarization with electro-myograph equipment.	1
7.	Anthropometric measurements of a selected subjects.	2
8.	Optimum work space layout and locations of controls for different tractors.	1
9.	Familiarization with the noise and vibration equipment	2
10.	Familiarization with safety gadgets for various farm machines.	2
	Total	**16**

Reference Books

1. Chapanis A. 1996. Human Factors in System Engineering. John Wiley & Sons, New York.
2. Dul J. and Weerdmeester B.1993. Ergonomics for Beginners. A Quick Reference Guide. Taylor and Francis, London.
3. Mathews J. and Knight A. A. 1971. Ergonomics in Agricultural Equipment Design. National Institute of Agricultural Engineering.
4. Astrand P. And and Rodahl K. 1977. Textbook of Work Physiology. Mc Hill Corporation, New York.
5. Mark S. Sanders and Ernest James McCormick. 1993. Human Factors in Engineering and Design. Mc Hill Corporation, New York.
6. Keegan J J, Radke AO. 1964. Designing vehicle seats for greater comfort. SAE Journal;72:50~5.
7. Yadav R, Tewari V.K. 1998. Tractor operator workplace design-a review. Journal of Terra mechanics 35: 41-53.

Sr. No.	Course Name	Course No.	Credit	L	P	T
14	**Tractor Design and Testing**	**FMPE-4.8.14**	**3 (2 + 1)**	**2**	**1**	**0**

Course content :

Theory

Procedure for design and development of agricultural tractor, Study of parameters for balanced design of tractor for stability & 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 solving. 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

S. No.	Topics to be covered in Lecture	Proposed No. of Lectures
1.	Procedure for design and development of agricultural tractor,	2
2.	Study of parameters for balanced design of tractor for stability & weight distribution, traction theory.	2
3.	Hydraulic lift and hitch system design	2
4.	Design of mechanical power transmission in agricultural tractors: single disc, multi disc and cone clutches.	2
5.	Rolling friction and anti-friction bearings.	1
6.	Design of Ackerman Steering and tractor hydraulic steering.	2
7.	Study of special design features of tractor engines and their selection viz. cylinder, piston, piston pin, crankshaft, etc.	2
8.	Design of seat and controls of an agricultural tractor.	2
9.	Tractor Testing.	2
	Total	**17**

Practicals

S. No.	Topic	No. of Practicals
1.	Design problem of tractor clutch – (Single/ Multiple disc clutch).	1
2.	Design of gear box (synchromesh/constant mesh), variable speed constant mesh drive.	2
3.	Selection of tractor tires – Problem solving.	2
4.	Problem on design of governor.	1
5.	Design and selection of hydraulic pump.	1
6.	Engine testing as per BIS code.	2
7.	Drawbar performance in the lab; PTO test and measure the tractor power in the lab/field.	1
8.	Determining the turning space, turning radius and brake test	1
9.	Hydraulic pump performance test	1
10.	Air cleaner and noise measurement test	1
11.	Visit to tractor testing centre/industry.	1
	Total	**16**

Reference Books

Liljedahl J B & Others. Tractors and Their Power Units.
Raymond N, EA Yong and S Nicolas. Vehicle Traction Mechanics.
Maleev VL. Internal Combustion Engines.
Kirpal Singh. Automobile Engineering – Vol I and Vol II.
Richey C.B. Agricultural Engineering Handbook.
Mehta ML, SR Verma, SK Mishra, VK Sharma. Testing & Evaluation of Agricultural Machinery.

Sr. No.	Course Name	Course No.	Credit	L	P	T
15	**Hydraulic Drives and Controls**	**FMPE-4.8.15**	**3 (2 + 1)**	**2**	**1**	**0**

Course content :

Theory

Hydraulic Basics: Pascal's Law, Flow, Energy, Work, and Power. Hydraulic Systems, Color Coding, Reservoirs, Strainers and Filters, Filtering Material and Elements. Accumulators, Pressure Gauges and Volume Meters, Hydraulic Circuit, Fittings and Connectors. Pumps, Pump Classifications, operation, performance, Displacement, Design ofGear 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 and Troubleshooting, United States of American Standards Institute USASI Graphical Symbols Tractor hydraulics, nudging system, ADDC. Pneumatics: Air services, logic units, Fail safe and safety systems Robotics: Application of Hydraulics and Pneumatics drives in agricultural systems, Programmable Logic Controls (PLCs).

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; Use of hydraulics and pneumatics for robotics.

Planning of lectures

S.No.	Topics to be covered in Lecture	Proposed No. of Lectures
1	Hydraulic Basics: Pascal's Law, Flow, Energy, Work, and Power.	3
2	Hydraulic Systems, Color Coding, Reservoirs, Strainers and Filters, Filtering Material and Elements.	3
3	Accumulators, Pressure Gauges and Volume Meters, Hydraulic Circuit, Fittings and Connectors.	3
4	Pumps, Pump Classifications, operation, performance, Displacement, Design of Gear Pumps, Vane Pumps, Piston Pumps.	4
5	Hydraulic Actuators, Cylinders, Construction and Applications, Maintenance, Hydraulic Motors.	3
6	Installation, Valve Failures and Remedies, Valve Assembly, Troubleshooting of Valves Hydraulic Circuit Diagrams and Troubleshooting,	3
7	United States of American Standards Institute USASI.	3
8	Graphical Symbolsin Tractor hydraulics, nudging system, ADDC.	3
9	Pneumatics: Air services, logic units, Fail safe and safety systems	3
10	Robotics: Application of Hydraulics and Pneumatics drives in agricultural systems, Programmable Logic Controls (PLCs).	4
	Total	**32**

Practicals

S. No.	Topic	No. of Practicals
1.	Introduction to hydraulic systems	2
2.	Study of hydraulic pumps, hydraulic actuators	2
3.	Study of hydraulic motors, hydraulic valves, colour codes and circuits	3
4.	Building simple hydraulic circuits.	2
5.	Study of hydraulics in tractors.	2
6.	Introduction to pneumatics, pneumatics devices, pneumatics in agriculture	3
7.	Use of hydraulics and pneumatics for robotics.	2
	Total	**16**

Reference Books

1. Kepner RA, Roy Barger & EL Barger. Principles of Farm Machinery.
2. Anthony E. Fluid Power and Applications.
3. Majumdar. Oil Hydraulic System.
4. Merit. Hydraulic Control Systems.
5. John Deere. Fundamentals of Service Hydraulics.

Sr.No.	Course Name	Course No.	Credit	L	P	T
16	**Precision Agriculture and System Management**	**FMPE- 412**	**3(2+1)**	**2**	**1**	**0**

Course Content:

Theory: Precision Agriculture – need and functional requirements. Familiarization with issues relating to natural resources. Familiarization with equipment for precision agriculture including sowing and planting machines, power sprayers, land clearing machines, laser guided land levellers, 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 to PERT and CPM for 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 and inflation and problems related to selection of equipment, replacement, break-even analysis, time value of money etc.

Sr. No.	Topic of course	Proposed No. of Lectures
1	Precision Agriculture – need and functional requirements	2
2	Familiarization with issues relating to natural resources	2
3	Familiarization with equipment for precision agriculture including sowing and planting machines	2
4	Power sprayers, land clearing machines, laser guided land levelers, straw-chopper, straw-balers, grain combines, etc	3
5	Introduction to GIS based precision agriculture and its applications.	3
6	Introduction to sensors and application of sensors for data generation	3
7	Database management.	2
8	System approach in farm machinery management	2
9	System concept	2
10	Problems on machinery selection	3
11	Maintenance and scheduling of operations	3
12	Application to PERT and CPM for machinery system management	3
13	Various application rates for fertilizer as well as for pesticides/weedicides	2
	Total	**32**

Practicals

Sr. No.	Topic	No. of Practicals
1	Familiarization with precision agriculture problems and issues	2
2	Familiarization with various machines for resource conservation	4
3	Solving problems related to various capacities, pattern efficiency, system limitation, etc	4
4	Problems related to cost analysis and inflation and problems related to selection of equipment, replacement, break-even analysis, time value of money etc.	4
	Total	**14**

Suggested Readings:

Kuhar J E. The Precision Farming Guide for Agriculturist.
Dutta SK. Soil Conservation and land management.
Sigma and Jagmohan. Earth Moving Machinery.
Wood and Stuart. Earth Moving Machinery.
DeMess MN. Fundamentals of Geographic Information System.
Hunt Donnell. Farm Power and Machinery Management.
Sharma DN and S Mukesh. Farm Power and Machinery Management Vol I.

Sr. No.	Course Name	Course No.	Credit	L	P	T
17	**Food quality and control**	**PFE-4.8.17**	**3 (2+1)**	**2**	**1**	**0**

Course content:

Theory

Basics of Food Science and Food Analysis, Concept, objectives and need of food quality. Measurement of colour, flavour, consistency, viscosity, texture and their relationship with food quality and composition. Sampling; purpose, sampling techniques, sampling procedures for liquid, powdered and granular materials, Quality control, Quality control tools, Statistical quality control, Sensory evaluation methods, panel selection methods, Interpretation of sensory results. Instrumental method for testing quality. Food adulteration and food safety. TQM and TQC, consumer preferences and acceptance, Food Safety Management Systems GAP, GHP, GMP, Hazards and HACCP (Hazard analysis and critical control point), Sanitation in food industry (SSOP), Food Laws and Regulations in India, FSSAI, Food grades and standards BIS, AGMARK, PFA, FPO, ISO 9000, 22000 Series. CAC (Codex Alimantarious Commission),Traceability and Quality Assurance system in a process plant, Bio safety and Bioterrorism.

Practical

Examination of cereals & pulses from one of go-downs and market shops in relation to FPO and BIS specifications, Detection of adulteration and examination of ghee for various standards of AGMARK & BIS standards, Detection of adulteration and examination of spices for AGMARK and BIS standards, Detection of adulteration and examination of milk and milk products for BIS standards, Detection of adulteration and examination of fruit products such as jams, jellys, marmalades for FPO specification, Visit to quality control laboratory, Case study of statistical process control in food processing industry, Study of registration process and licensing procedure under FSSAI, Study of sampling techniques from food processing establishments, Visit to food processing laboratory and study of records and reports maintained by food processing laboratory.

Planning of lectures

S. No.	Topics to be covered in Lecture	Proposed No. of Lectures
1	Basics of Food Science and Food Analysis and Concepts	1
2	Objectives and need of food quality	1
3	Measurement of colour, flavour, consistency, viscosity, texture and their relationship with food quality and composition.	3
4	Sampling; purpose, sampling techniques, sampling procedures for liquid, powdered and granular materials	2
5	Quality control, Quality control tools	3
6	Statistical quality control	2
7	Sensory evaluation methods, panel selection methods	2
8	Interpretation of sensory results	1
9	Instrumental method for testing quality	2
10	Food adulteration and food safety	3
11	TQM and TQC, consumer preferences and acceptance	1
12	Food Safety Management Systems GAP, GHP, GMP, Hazards and HACCP (Hazard analysis and critical control point)	2
13	Sanitation in food industry (SSOP)	2
14	Food Laws and Regulations in India	2
15	FSSAI, Food grades and standards BIS, AGMARK, PFA, FPO, ISO 9000, 22000 Series	3
16	CAC (Codex Alimantarious Commission),Traceability and Quality Assurance system in a process plant, Bio safety and Bioterrorism	2
Total		**32**

Practical

S.No.	17. Topic	No. of Practical
1	Examination of cereals & pulses from one of go-downs and market shops in	2

	relation to FPO and BIS specifications	
2	Detection of adulteration and examination of ghee for various standards of AGMARK & BIS standards	1
3	Detection of adulteration and examination of spices for AGMARK and BIS standards	1
4	Detection of adulteration and examination of milk and milk products for BIS standards	2
5	Detection of adulteration and examination of fruit products such as jams, jellys, marmalades for FPO specification	1
6	Visit to quality control laboratory	1
7	Case study of statistical process control in food processing industry	2
8	Study of registration process and licensing procedure under FSSAI	2
9	Study of sampling techniques from food processing establishments	1
10	Visit to food processing laboratory	1
11	Study of records and reports maintained by food processing laboratory	2
	Total	**16**

Suggested Readings

Ranganna S. Hand book of Analysis and Quality Control for Fruit and Vegetable Products.
Srilakshmi B, Food Science.
Sharma Avanthi. A text book of Food Science and Technology.
Mudambi Sumati R, Rao Shalini M and Rajagopal M.V. Food Science.
Potter NN and Hotchkiss JH, Food Science.
Dev Raj, Rakesh Sharma and Joshi V.K, Quality for Value Addition in Food Processing.
The Food Safety and Standards Act along with Rules & Regulations. Commercial Law Publishers (India) Pvt. Ltd.

Sr. No.	Course Name	Course No.	Credit	L	P	T
18	**Food Plant Design and Management**	**PFE-4.8.18**	**3 (2+1)**	**2**	**1**	**0**

Course content:

Theory

Food plant location, selection criteria, Selection of processes, plant capacity, Requirements of plant building and its components, Project design, flow diagrams, selection of equipment, process and controls, Objectives and principles of food plant layout. Salient features of processing plants for cereals, pulses, oilseeds, horticultural and vegetable crops, poultry, fish and meat products, milk and milk products. Introduction to Finance, Food Product Marketing, Food Business Analysis and Strategic Planning, Introduction to Marketing, Food Marketing Management, Supply chain management for retail food products, Entrepreneurship development in food industry, SWOT analysis, generation, incubation and commercialization of ideas and innovations, New product development process, Government schemes and incentive for promotion of entrepreneurship, Govt. policy on small and medium scale food processing enterprise, export and import policies relevant to food processing sector, procedure of obtaining license and registration under FSSAI, Cost analysis and preparation of feasibility report.

Practical

Preparation of project report, Preparation of feasibility report, Salient features and layout of pre processing house, Salient features and layout of Milk and Milk product plants, Evaluation of given layout, Salient features, design and layout of modern rice mill, Salient features, design and layout of Bakery and related product plant, Study of different types of records relating to production of a food plant, Study of different types of records relating to finance of a food plant, Study of different types of records relating to marketing of a food business, Brain storming and SWOT analysis to start a food processing business.

Planning of lectures

S. No.	Topics to be covered in Lecture	Proposed No. of Lectures
1	Selection criteria of food plant location	1
2	Selection of processes, plant capacity	1
3	Requirements of plant building and its components	1
4	Project design, flow diagrams, selection of equipment, process and controls	2
5	Objectives and principles of food plant layout	1
6	Salient features of processing plants for cereals, pulses, oilseeds, horticultural and vegetable crops, poultry, fish and meat products, milk and milk products	3
7	Introduction to Finance	1
8	Introduction to Marketing and Food Product Marketing	1
9	Food Business Analysis and Strategic Planning	2
10	Supply chain management for retail food products	2
11	Entrepreneurship development in food industry	3
12	SWOT analysis, generation, incubation and commercialization of ideas and innovations	2
13	New product development process	2
14	Government schemes and incentive for promotion of entrepreneurship	2
15	Govt. policy on small and medium scale food processing enterprise, export and import policies relevant to food processing sector	3
16	procedure of obtaining license and registration under FSSAI	2
17	Cost analysis and preparation of feasibility report	3
Total		**32**

Practical

S.No.	18. Topic	No. of Practical
1	Preparation of project report	1
2	Preparation of feasibility report	1
3	Salient features and layout of pre processing house	1
4	Salient features and layout of Milk and Milk product plants	1

5	Evaluation of given layout	1
6	Salient features, design and layout of modern rice mill,	1
7	Salient features, design and layout of Bakery and related product plant	1
8	Study of different types of records relating to production of a food plant	1
9	Study of different types of records relating to finance of a food plant	1
10	Study of different types of records relating to marketing of a food business	1
11	Presentations, Brain storming and SWOT analysis to start a food processing business	6
	Total	**16**

Suggested Readings

Hall, H.S. and Rosen, Y.S. Milk Plant Layout. FAO Publication, Rome.
López Antonio. Gómez. Food Plant Design.
Robberts Theunis C. Food plant engineering systems by, CRC Press, Washington.
Maroulis Z B and Saravacos G D. Food plant economics. Taylor and Francis, LLC
Mahajan M. Operations Research. Dhanpat Rai and Company Private Limited, Delhi
Maroulis Z B. Food Process Design. Marcel Dekker, Inc ,Cimarron Road, Monticello, New York 12701, USA.

Sr. No.	Course Name	Course No.	Credit	L	P	T
19	**Food Packaging Technology**	**PFE-4.8.19**	**3 (2+1)**	**2**	**1**	**0**

Course content:

Theory:

Factors affecting shelf life of food material during storage, Interactions of spoilage agents with environmental factors as water, oxygen, light, pH, etc. and general principles of control of the spoilage agents; Difference between food infection, food intoxication and allergy. Packaging of foods, requirement, importance and scope, frame work of packaging strategy, environmental considerations, Packaging systems, types: flexible and rigid; retail and bulk; levels of packaging; special solutions and packaging machines, technical packaging systems and data management packaging systems, Different types of packaging materials, their key properties and applications, Metal cans, manufacture of two piece and three piece cans, Plastic packaging, different types of polymers used in food packaging and their barrier properties. manufacture of plastic packaging materials, profile extrusion, blown film/ sheet extrusion, blow molding, extrusion blow molding, injection blow molding, stretch blow molding, injection molding. Glass containers, types of glass used in food packaging, manufacture of glass and glass containers, closures for glass containers. Paper and paper board packaging, paper and paper board manufacture process, modification of barrier properties and characteristics of paper/ boards. Relative advantages and disadvantages of different packaging materials; effect of these materials on packed commodities. Nutritional labelling on packages, CAS and MAP, shrink and cling packaging, vacuum and gas packaging; Active packaging, Smart packaging, Packaging requirement for raw and processed foods, and their selection of packaging materials, Factors affecting the choice of packaging materials, Disposal and recycle of packaging waste, Printing and labelling, Lamination, Package testing: Testing methods for flexible materials, rigid materials and semi rigid materials; Tests for paper (thickness, bursting strength, breaking length, stiffness, tear resistance, folding endurance, ply bond test, surface oil absorption test, etc.), plastic film and laminates (thickness, tensile strength, gloss, haze, burning test to identify polymer, etc.), aluminium foil (thickness, pin holes, etc.), glass containers (visual defects, colour, dimensions, impact strength, etc.), metal containers (pressure test, product compatibility, etc.).

Practical:

Identification of different types of packaging materials, Determination of tensile/ compressive strength of given material/package, To perform different destructive and non-destructive tests for glass containers, Vacuum packaging of agricultural produces, Determination of tearing strength of paper board, Measurement of thickness of packaging materials, To perform grease-resistance test in plastic pouches, Determination of bursting strength of packaging material, Determination of water-vapour transmission rate, Shrink wrapping of various horticultural produce, Testing of chemical resistance of packaging materials, Determination of drop test of food package and visit to relevant industries.

Planning of lectures

S. No.	Topics to be covered in Lecture	Proposed No. of Lectures
1	Factors affecting shelf life of food material during storage	1
2	Interactions of spoilage agents with environmental factors as water, oxygen, light, pH, etc. and general principles of control of the spoilage agents; Difference between food infection, food intoxication and allergy	3
3	Packaging of foods, requirement, importance and scope, frame work of packaging strategy, environmental considerations,	2
4	Packaging systems, types: flexible and rigid; retail and bulk; levels of packaging; special solutions and packaging machines, technical packaging systems and data management packaging systems	2
5	Different types of packaging materials, their key properties and applications, Metal cans, manufacture of two piece and three piece cans,	3
6	Plastic packaging, different types of polymers used in food packaging and their barrier properties. manufacture of plastic packaging materials, profile extrusion, blown film/ sheet extrusion, blow molding, extrusion blow molding, injection blow molding, stretch blow molding, injection molding	3

7	Glass containers, types of glass used in food packaging, manufacture of glass and glass containers, closures for glass containers.	1
8	Paper and paper board packaging, paper and paper board manufacture process, modification of barrier properties and characteristics of paper/ boards	1
9	Relative advantages and disadvantages of different packaging materials; effect of these materials on packed commodities.	2
10	Effect of these materials on packed commodities. Nutritional labelling on packages, CAS and MAP, shrink and cling packaging, vacuum and gas packaging; Active packaging, Smart packaging, Packaging requirement for raw and processed foods, and their selection of packaging materials	3
11	Factors affecting the choice of packaging materials, Disposal and recycle of packaging waste, Printing and labelling, Lamination	3
12	Package testing: Testing methods for flexible materials, rigid materials and semi rigid materials; Tests for paper (thickness, bursting strength, breaking length, stiffness, tear resistance, folding endurance, ply bond test, surface oil absorption test, etc.),	3
13	Plastic film and laminates (thickness, tensile strength, gloss, haze, burning test to identify polymer, etc.),	2
14	Aluminum foil (thickness, pin holes, etc.), glass containers (visual defects, colour, dimensions, impact strength, etc.), metal containers (pressure test, product compatibility, etc.).	3
Total		**32**
Practical's		
S.No.	**19. 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 water-vapour 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:

Coles, R., McDowell, D., Kirwan, M .J. 2003. Food Packaging Technology. Blackwell Publishing Co.
Gosby, N.T. 2001. Food Packaging Materials. Applied Science Publication
John, P.J. 2008. A Handbook on Food Packaging Narendra Publishing House,
Mahadevia, M., Gowramma, R.V. 2007. Food Packaging Materials. Tata McGraw Hill
Robertson, G. L. 2001. Food Packaging and Shelf life: A Practical Guide. Narendra Publishing House.
Robertson, G. L. 2005. Food Packaging: Principles and Practice. Second Edition. Taylor and Francis Pub.

Sr. No.	Course Name	Course No.	Credit	L	P	T
20	Development of Processed Products	PFE-4.8.20	3 (2+1)	2	1	0

Course content:

Theory

Process design, Process flow chart with mass and energy balance, Water activity, Unit operations and equipments for processing, New product development, Technology for value added products from cereal, pulses and oil seeds, Milling, puffing, flaking, Roasting, Bakery products, snack food. Extruded products, oil extraction and refining, Technology for value added products from fruits, vegetables and spices, Canned foods, Frozen foods, dried and fried foods, Fruit juices, Sauce, Sugar based confection, Candy, Fermented food product, Cryogenic grinding and critical fluid extraction technology, Technology for animal produce processing , meat, poultry, fish, egg products, Health food, Nutra-ceuticals and functional food, Organic food.

Practical

Process design and process flow chart preparation, preparation of different value added products, Visit to roller wheat flour milling, rice milling, spice grinding mill, milk plant, dal and oil mill, fruit/vegetable processing plants & study of operations and machinery, Process flow diagram and study of various models of the machines used in a sugar mill.

Planning of lectures

S. No.	Topics to be covered in Lecture	Proposed No. of Lectures
1	Process design	1
2	Water activity and concept of mass and energy balance	2
3	Process flow chart with mass and energy balance	1
4	New product development	2
5	Technology for value added products from cereal, pulses and oil seeds	3
6	Milling, puffing, flaking, Roasting, Bakery products, snack food	3
7	Extruded products	1
8	Oil extraction and refining	1
9	Technology for value added products from fruits, vegetables and spices	3
10	Canned foods and Frozen foods	2
11	Fruit juices, Sauce, Sugar based confection, Candy,	2
12	Fermented food product	1
13	Cryogenic grinding and critical fluid extraction technology	2
14	Technology for animal produce processing	2
15	Meat, poultry, fish, egg products,	2
16	Health food, Nutra-ceuticals and functional food	2
17	Organic food	2
Total		**32**

Practical

S.No.	20. Topic	No. of Practical
1	Process design and process flow chart preparation	3
2	Preparation of different value added products	4
3	Visit/ study of to roller wheat flour milling, rice milling, spice grinding mill,	3
4	Visit/ study of milk plant, dal and oil mill fruit/vegetable processing plants	3
5	Study of operations and machinery	1
6	Study of Process flow diagram	1
7	Study of various models of the machines used in a sugar mill/ processing plants	1
	Total	**16**

Suggested Readings

Geankoplis C. J. Transport processes and unit operations, Prentice-Hall.
Rao, D. G. Fundamentals of Food Engineering PHI Learning Pvt. Ltd, New Delhi.

Norman N. Potter and Joseph H. Hotchikss. Food Science. Chapman and Hall Pub.
Acharya, K T Everyday Indian Processed foods. National Book Trust.
Mudambi Sumati R., Shalini M. Rao and M V Rajgopal. Food Science. New Age International Publishers.
Negi H.P.S., Savita Sharma, K. S. Sekhon. Hand book of Cereal technology. Kalyani Pub.
K. P. Sudheer, V. Indira 2007. Post Harvest Technology of Horticultural Crops, New India Publishing

Sr. No.	Course Name	Course No.	Credit	L	P	T
21	**Process Equipment Design**	**PFE-4.8.21**	**3 (2+1)**	**2**	**1**	**0**

Course content:

Theory :Introduction on process equipment design, Application of design engineering for processing equipments, Design parameters and general design procedure, Material specification, Types of material for process equipments, 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 dryers. Design of milling equipments. Optimization of design with respect to process efficiency, energy and cost, Computer Aided Design.

Practical: Design of pressure vessel, cleaners, milling equipments, tubular heat exchanger, shell and tube type heat exchanger, plate heat exchanger, dryer, belt conveyor, bucket elevator, screw conveyor.

Planning of lectures

S. No.	Topics to be covered in Lecture	Proposed No. of Lectures
1	Introduction on process equipment design	1
2	Application of design engineering for processing equipments	1
3	Design parameters and general design procedure	1
4	Material specification	1
5	Types of material for process equipments	1
6	Design codes	1
7	Pressure vessel design	3
8	Design of cleaners	2
9	Design of tubular heat exchanger	2
10	shell and tube heat exchanger	2
11	plate heat exchanger	2
12	Design of belt conveyer	2
13	Design of screw conveyer	2
14	Design of bucket elevator	2
15	Design of dryers	3
16	Design of milling equipments	2
17	Optimization of design with respect to process efficiency energy and cost	2
18	Computer Aided Design	2
Total		**32**

Practical

S.No.	21. Topic	No. of Practical
1	Design of pressure vessel	1
2	Design of cleaners	2
3	Design of, milling equipments	2
4	Design of tubular heat exchanger	2
5	Design of shell and tube type heat exchanger	1
6	Design of plate heat exchanger	1
7	Design of dryer, belt conveyor, bucket elevator, screw conveyor	1
8	Design of belt conveyor	2
9	Design of bucket elevator	2
10	Design of screw conveyor	2
	Total	**16**

Suggested Readings

Mahajani, V. V. and Umarji, S. B., Joshi's Process equipment design, Macmillan.
Bhattacharyya, B. C., Introduction to Chemical Equipment design, CBS Publishers and Distributors.
Geankoplis C. J. Transport processes and unit operations, Prentice-Hall.
Rao, D. G. Fundamentals of Food Engineering PHI Learning Pvt. Ltd, New Delhi.

Sr. No.	Course Name	Course No.	Credit	L	P	T
22	**Photovoltaic Technology and Systems**	**REE-4.8.22**	**3 (2+1)**	**2**	**1**	**0**

Course Content:

Solar PV Technology: Advantages, Limitations, Current Status of PV technology, SWOT analysis of PV technology. Types of Solar Cell, 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: Introduction to batteries, battery classification, lead acid battery, Nicked Cadmium battery, comparison of batteries, battery parameters, Charge controller: types of charge controller, function of charge controller, PWM type, MPPT 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

S. No.	Topics to be covered in Lecture	Proposed No. of Lectures
1	Solar PV Technology: Advantages, Limitations, Current Status of PV technology.	2
2	SWOT analysis of PV technology.	3
3	Types of Solar Cell, 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.	4
4	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.	4
5	Balance of Solar PV system: Introduction to batteries, battery classification, lead acid battery, Nicked Cadmium battery, comparison of batteries, battery parameters.	3
6	Charge controller: types of charge controller, function of charge controller, PWM type, MPPT type charge controller.	3
7	Converters: DC to DC converter and DC to AC type converter.	3
8	Application of Solar PV system. Solar home lighting system, solar lantern, solar fencing, solar street light, solar water pumping system.	3
9	Roof top solar photovoltaic power plant and smart grid.	3
	Total	28

Planning of Practical

S.No.	Topics	Proposed No. of Practical
1	Study and demonstration different types of solar cells	1
2	Study of V-I characteristics of solar PV system	1
3	Study of smart grid technology and application	1
4	Study and demonstration of manufacturing technique of solar array	1
5	Study of different DC to DC and DC to AC converter	1
6	Study and demonstration of domestic solar lighting system	1
7	Study of various solar module technologies	1
8	Study of safe measurement of PV modules electrical characteristics	1

9	Commissioning of complete solar PV system	1
10	Visit to various industries manufacturing the solar photovoltaic system	1
	Total	**10**

Suggested Readings

British BioGen. 1997, Anaerobic digestion of farm and food processing practices- Good practice guidelines, London, available on www.britishbiogen.co.UK.

Butler, S. 2005. Renewable Energy Academy: Training wood energy professionals.

Centre for biomass energy. 1998. Straw for energy production; Technology- Environment- Ecology. Available: www.ens.dk.

Solar photovoltaic - fundamentals, technologies and applications, third edition by solanki, chetan singh ISBN: 978-81-203-5111-0.

Sr. No.	Course Name	Course No.	Credit	L	P	T
23	**Waste and By-Products Utilization**	**REE-4.8.23**	**3 (2+1)**	**2**	**1**	**0**

Course Content:

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, 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 byproducts, 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, concept of vermin-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; and biogas generation, 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.

Planning of Lectures

S. No.	Topics to be covered in Lecture	Proposed No. of Lectures
1	Types and formation of by-products and waste; Magnitude of waste generation in different food processing industries.	2
2	Uses of different agricultural by-products from rice mill, sugarcane industry, oil mill etc..	2
3	Concept, scope and maintenance of waste management and effluent treatment, 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	4
4	Waste utilization in various industries.	2
5	Furnaces and boilers run on agricultural wastes and byproducts, briquetting of biomass as fuel, production of charcoal briquette, generation of electricity using surplus biomass, producer gas generation and utilization	4
6	Waste treatment and disposal, design, construction, operation and management of institutional community and family size biogas plants, concept of vermin-composting.	4
7	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.	4
8	Tertiary treatments: Advanced waste water treatment process-sand, coal and activated carbon filters, phosphorous, sulphur, nitrogen and heavy metals removal.	3
9	Assessment, treatment and disposal of solid waste; and biogas generation, Effluent treatment plants.	2
10	Environmental performance of food industry to comply with ISO-14001 standards.	2
	Total	29

Planning of Practical		
S.No.	Topics	Proposed No. of practical
1	Determination of temperature pH, turbidity solids content	1
2	Determination of BOD of waste water	1
3	Determination of COD of waste water	1
4	Determination of ash content of agricultural wastes	1
5	Determination of un-burnt carbon in ash	1
6	Study about briquetting of agricultural residues	1
7	Estimation of excess air for better combustion of briquettes/wood	1
8	Study of extraction of oil from rice bran	1
9	Study on bioconversion of agricultural wastes	1
10	Recovery of germ and germ oil from by-products of cereals	1
11	Visit to various industries using waste and food by-products	2
	Total	**12**

Suggested Readings

Markel, I.A. 1981. Managing Livestock Waste, AVI Publishing Co.

Pantastico, ECB. 1975. Post Harvest Physiology, Handling and utilization of Tropical and Sub-tropical fruits and vegetables, AVI Pub. Co.

Shewfelt, R.L. and Prussi, S.E. 1992. Post-Harvest Handling – A Systems approach, Academic Press Inc.

USDA. 1992. Agricultural Waste Management Field Hand book. USDA, Washington DC.

Weichmann J. 1987. Post Harvest Physiology of vegetables, Marcel and Dekker Verlag.

V.K. Joshi & S.K. Sharma. Food Processing Waste Management: Treatment & Utilization. New India Publishing Agency.

Vasso Oreopoulou and Winfried Russ (Edited). 2007. Utilization of By-products and Treatment of waste in the Food Industry. Springer Science & Business media, LLC 233 New York.

Prashar, Anupama and Bansal, Pratibha. 2007-08. Industrial Safety and Environment. S.K. Kataria and sons, New Delhi

Garg, S K. 1998. Environmental Engineering (Vol. II) – Sewage Disposal and Air Pollution Engineering. Khanna Publishers, New Delhi

Bhatia, S.C.. 2001. Environmental Pollution and Control in Chemical Process Industries. Khanna Publishers, New Delhi.

Sr. No.	Course Name	Course No.	Credit	L	P	T
24	Artificial Intelligence	CSE-4.8.24	3(3+0)	3	0	0

Course content:

Theory: Foundation and history of artificial intelligent, problems and techniques – AI programming languages, introduction to LISP and PROLOG- problem spaces and searches, blind search strategies, Breadth first- Depth first- heuristic search techniques Hill climbing: best first-A* algorithm AO* algorithm- game tree, Min max algorithms, game playing- alpha beta pruning. Knowledge representation issues, predicate logic- logic programming, semantic nets- frames and inheritance, constraint propagation, representing knowledge using rules, rules based deduction systems. Reasoning under uncertainty, review of probability, Baye's probabilistic interferences and Dempster shafer theory, Heuristic methods, symbolic reasoning under uncertainty, Statistical reasoning, Fuzzy reasoning, Temporal reasoning, Non monotonic reasoning. Planning and planning in situational calculus, representation for planning, partial order planning algorithm, learning from examples, discovery as learning, learning by analogy, explanation based learning, neural nets, genetic algorithms. Principles of Natural language processing, rule based systems architecture, Expert systems, knowledge acquisition concepts, AI application to robotics, and current trends in intelligent systems.

Planning of lectures

S. No.	Topics to be covered in Lecture	Proposed No. of Lectures
1	Foundation and history of artificial intelligent, problems and techniques	2
2	AI programming languages, introduction to LISP and PROLOG	2
3	problem spaces and searches, blind search strategies, Breadth first- Depth first- heuristic search techniques	4
4	Hill climbing: best first-A* algorithm AO* algorithm- game tree, Min max algorithms, game playing- alpha beta pruning	5
5	Knowledge representation issues, predicate logic- logic programming, semantic nets- frames and inheritance, constraint propagation, representing knowledge using rules, rules based deduction systems	8
6	Reasoning under uncertainty, review of probability, Baye's probabilistic interferences and Dempster shafer theory, Heuristic methods, symbolic reasoning under uncertainty, Statistical reasoning, Fuzzy reasoning, Temporal reasoning, Non monotonic reasoning	7
7	Planning and planning in situational calculus, representation for planning, partial order planning algorithm, learning from examples, discovery as learning, learning by analogy, explanation based learning, neural nets, genetic algorithms	8
8	Principles of Natural language processing, rule based systems architecture, Expert systems, knowledge acquisition concepts, AI application to robotics, and current trends in intelligent systems	9
Total		**45**

Suggested Readings

Russell, S. and P. Norvig. 1998. Artificial Intelligence: A Modern Approach. Prentice Hall.
Rich, Elain and Kevin Knight. 1991. Artificial Intelligence. TMH.
Patrick Henry Winston. 1992. Artificial intelligence. Addition Wesley 3rd Ed.
Nilson Nils J. Principles of Artificial Intelligence. Norsa Publishing House.

Sr. No.	Course Name	Course No.	Credit	L	P	T
25.	Mechatronics	ME-4.8.25	3 (2+1)	2	1	0

Course content:

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, Mechanical Actuation Systems, Hydraulic & Pneumatic Actuation Systems, Electrical Actuation Systems, A.C. Motor, D.C. Motor, Stepper Motor. Signal conditioning process, filtering digital signal, multiplexers, data acquisition, digital signal processing, measurement system, 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 components, robot classification and specification, 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

Selection of sensor for a particular application from Catalogue/Internet. Design a mechatronics product/system and incorporate application of mechatronics for enhancing product values. To study the hardware and software of mechatronics kit. To move a table in X-direction within the range of proximity sensors using Control-X software. To run a motor with PLC. To run a conveyor with computer. To study the movement of actuating cylinders and sensors.

Planning of lectures

S. No.	Topics to be covered in Lecture	Proposed No. of Lectures
1	Definition of mechatronics, measurement system	1
2	control systems, microprocessor based controllers	1
3	mechatronics approach. Sensors and transducers	2
4	performance terminology, Displacement, Position & Proximity Sensors, photo-electric transducers, flow transducers, optical sensors and transducers	2
5	Actuators, Mechanical Actuation Systems, Hydraulic & Pneumatic Actuation Systems, Electrical Actuation Systems	2
6	A.C. Motor, D.C. Motor, Stepper Motor. Signal conditioning process, filtering digital signal, multiplexers,	2
7	data acquisition, digital signal processing, measurement system, pulse modulation, data presentation systems	3
8	System modelling & control, Mathematical Models, Engineering Systems, Electro-mechanical & Hydraulic-mechanical Systems,	4
9	Modelling Dynamic Systems, Transfer Functions,	3
10	Control Modes, PID Controller. Micro-processor & computer, Computer and Interfacing, Micro-computer Structure, Micro-controllers	3
11	Application of Microcontrollers, PLC. Robotics, Robot components	3
12	robot classification and specification, Work envelopes, other basic parameters of robots.	2
13	Robot applications, Robot applications in manufacturing,	1
14	Material transfer and machine loading/unloading	1
15	Processing operations like Welding & painting, Assembly operations, Inspection automation, Future applications	3

Total		33
Tutorials		
S.No.	22. **Topic**	**No. of Practicals**
1.	Design a mechatronics product/system and incorporate application of mechatronics for enhancing product values using rapid proto Typing Machine	2
2.	To study the hardware and software of mechatronics kit.	2
3.	To run a motor with PLC. To run a conveyor with computer	1
4.	To move a table in X-direction within the range of proximity sensors using Control-X software	1
5.	To study the movement of actuating cylinders and sensors.	1
6.	Study and demonstration on Robots	1
7.	Introduction to CAD software.	2
8.	Introduction to CAM software	2
9.	Manual part programming on CNC lathe,	2
10.	Manual part programming on milling and drilling	**2**
11.	Simulation on CNC lathe	**2**
12.	Simulation on CNC Mill	**2**
	Total	**20**

Suggested Readings

Bolton, W. Mechatronics. Pearson Education Asia.
Wolfram, Stadler. Analytical Robotics and Mechatronics. Mc-Graw Hill.
Doeblin E.O. Measurement Systems. Mc-Graw Hill.
Mahind, A.P. Introduction to Digital Computer Electronics. TMH.
Niku, S.Y. Introduction to Robotics: Analysis, systems and applications", Pearson Education Asia.
Craig, J.J. Introduction to Robotics. Pearson Education Asia.

Sr. No.	Course Name	Course No.	Credit	L	P	T
26	**Energy Conservation and Audit in Agricultural Industry**	**REE-4.8.26**	**3 (2+1)**	**2**	**1**	**0**

Course Content: General energy problem, Energy consumption in Agriculture Sector and other sectors, demand supply gap, Scope for energy conservation and its benefits, Energy conservation Principle-Maximum energy efficiency, Maximum cost effectiveness, Features of EC act Standards and labeling, designated consumers, Energy conservation Building codes (ECBC), Energy management concept and objectives, Initialing planning, Leading controlling, Promoting, Monitoring and reporting, Energy management programmes, Energy saving opportunities in electric motors, benefits of power factor improvement and its techniques-shunt capacitor, synchronous condenser etc, effects of harmonics on motors and remedies leading to energy conservation, energy conservation by VSD, Energy conservation in electric furnaces, ovens and boilers, lighting techniques- Natural, CFL, LED lighting sources and fittings,New Equipment technology, staffing , training, calculation and costing of energy conservation project, Depreciation, cost, sinking fund method cost evaluation by return on Investment (ROI) and pay back method etc, Risk analysis, case analysis, Performance improvement of existing power plant, cogeneration, small hydro, DG set, Demand side management, load response programmes; Types of tariff and restructuring of electric tariff Technical measures to optimize T and D losses, Energy audit and its benefits, Energy flow diagram Preliminary, Detailed energy audit. Methodology of -preliminary energy audit and Detailed energy audit –Phase I, Pre audit, Phase II- Audit and Phase III- Post audit, Energy audit report, Electrical Measuring Instruments - Power Analyser. Combustion analyzer, fuel efficiency monitor, thermometer-contact, infrared, pitot tube and manometer, water flowmeter, leak detector, tachometer and luxmeter, IE rules and regulations for energy audit Electricity act(Numerical).

Practical: CASE STUDY OF AGRO INDUSRY FOR THE FOLLOWING SUB STUDIES:

List various energy management systems prevailing in a Agro industry/Organization; Identify the energy management skills and strategies in the energy management system; Organize a energy management programme in a given industry; List the various energy conservation methods useful in a particular industry; Identify the critical areas where energy conservation is required; Select appropriate energy conservation method for the critical area identified; List the various energy conservation methods useful in power generation, transmission and distribution; Find out the payback period for a given energy conservation equipment; Determine depreciation cost of a given energy conservation project/equipment; Draw the energy flow diagram for a industry/shop floor division; Identify various measuring instruments used for energy audit; Use various measuring instruments for carrying out energy audit; Prepare a sample energy audit questionnaire; Prepare a energy audit report; Prepare a technical report on energy conservation act 2003; Prepare a technical report on ECBC 2.

Planning of Lectures

S. No.	Topics to be covered in Lecture	Proposed No. of Lectures
1	General energy problem, Energy consumption in Agriculture Sector and other sectors, demand supply gap, Scope for energy conservation and its benefits	2
2	Energy conservation Principle-Maximum energy efficiency, Maximum cost effectiveness, Features of EC act Standards and labeling, designated consumers, Energy conservation Building codes (ECBC)	3
3	Energy management concept and objectives, Initialing planning, Leading controlling, Promoting, Monitoring and reporting, Energy management programmes	3
4	Energy saving opportunities in electric motors, benefits of power factor improvement and its techniques-shunt capacitor, synchronous condenser etc	3
5	effects of harmonics on motors and remedies leading to energy conservation, energy conservation by VSD	2
6	Energy conservation in electric furnaces, ovens and boilers, lighting techniques- Natural, CFL, LED lighting sources and fittings	3
7	New Equipment technology, staffing , training, calculation and costing of energy conservation project, Depreciation, cost, sinking fund method cost evaluation by return on Investment (ROI) and pay back method etc,	3
8	Risk analysis, case analysis, Performance improvement of existing power plant, cogeneration, small hydro, DG set, Demand side management, load response programmes	3
9	Types of tariff and restructuring of electric tariff Technical measures to optimize T and D	2

	losses,	
10	Energy audit and its benefits, Energy flow diagram Preliminary, Detailed energy audit. Methodology of -preliminary energy audit and Detailed energy audit –Phase I, Pre audit, Phase II- Audit and Phase III- Post audit and Energy audit report	3
11	Electrical Measuring Instruments - Power Analyzer. Combustion analyzer, fuel efficiency monitor, thermometer-contact, infrared, pitot tube and manometer, water flow meter, leak detector, tachometer and lux meter	2
12	IE rules and regulations for energy audit Electricity act(Numerical).	2
	Total	32

Planning of Practical

S.No.	Topics	Proposed No. of Practicals
1	List various energy management systems prevailing in a Agro industry/Organization	1
2	Identify the energy management skills and strategies in the energy management system.	1
3	Organize a energy management programme in a given industry	1
4	List the various energy conservation methods useful in a particular industry	1
5	Identify the critical areas where energy conservation is required	1
6	List the various energy conservation methods useful in power generation, transmission and distribution	1
7	Select appropriate energy conservation method for the critical area identified	1
8	Find out the payback period for a given energy conservation equipment	1
9	Determine depreciation cost of a given energy conservation project/equipment	1
10	Draw the energy flow diagram for a industry/shop floor division	1
11	Identify various measuring instruments used for energy audit	1
12	Use various measuring instruments for carrying out energy audit	1
13	Prepare a sample energy audit questionnaire	1
14	Prepare a energy audit report	1
15	Prepare a technical report on energy conservation act 2003	1
16	Prepare a technical report on ECBC 2	1
	Total	**16**

References:

Electric Energy Generation, Utilisation and Conservation. Sivaganaraju, S Pearson, New Delhi, 2012

Electrical Power V. K. Mehta Khanna and Khanna Publishers, New Dehli

Electrical Power S. L. Uppal Khanna and Khanna Publishers, New Dehli

Art and Science of utilization of Electrical Energy H. Partab Dhanapat Rai and Sons, New Dehli

Prasanna Chandra Project Management Tata Mcgraw Hill, New Delhi

Prasanna Chandra Financial Management Tata Mcgraw Hill, New Delh

Wayne C. Turner Energy Management Handbook –

Paul O Callaghan Energy management Mcgraw Hill, New Delhi

www.bee-india.com Fundamentals of electrical system Bureau of Energy Efficiency