Annexure-I

Semester wise Existing and Proposed Course Curriculum of Polytechnic in Agricultural Engineering

(Effective from 2025-26)

Existing course(s)			Proposed course(s)			Rem-arks
Course No.	**Course Title**	**Credit hours**	**Course No.**	**Course Title**	**Credit hours**	
Semester-I						
HBS-1.1.1	English	1+1=02	AE1.1	Deeksharambh	NG (0+2*)	
HBS-1.1.2	Applied Mathematics	4+0=04	AE1.2	Applied Chemistry	3(2+1)	
HBS-1.1.3	Applied Physics	2+1=03	AE1.3	Applied Mathematics	3(3+0)	
HBS-1.1.4	Applied Chemistry	1+1=02	AE1.4	Applied Physics	3(2+1)	
AGS-1.1.5	Soil Science & Agriculture For Engineers	2+1=03	AE1.5	English	2(1+1**)	
FMP-1.1.6	Workshop Technology and Practice	1+2=03	AE1.6	Farming Based Livelihood Systems	3(2+1)	
FMP-1.1.7	Engineering Drawing	0+2=02	AE1.7	Workshop Technology and Practice	2(0+2)	
PE-1.1.8	NSS/NCC/Phy.Edu. (NG)	--	AE1.8	NSS-I/NCC-I/Phy. Edu.	1(0+1)	
Total		**19(11+8)**	**Total**		**17(10+7+2*)**	
Semester-II						
HBS-1.2.1	Communication Skills	2+0=02	AE2.1	Crop Production and Protection Technology	3(2+1)	
HBS-1.2.2	Engineering Mathematics – I	2+1=03	AE2.2	Engineering Chemistry	2(1+1)	
HBS-1.2.3	Engineering Chemistry	2+1=03	AE2.3	Engineering Drawing	2(0+2)	
HBS-1.2.4	Engineering Physics	2+1=03	AE2.4	Engineering Mathematics	3(3+0)	
SWE-1.2.5	Surveying and Leveling	1+2=03	AE2.5	Engineering Mechanics	2(1+1)	
FMP-1.2.6	Engineering Mechanics	2+1=03	AE2.6	Engineering Physics	2(1+1)	
REE-1.2.7	Basics of Electrical Engineering and Electric circuits	3+1=04	AE2.7	General Microbiology	3(2+1)	
PE-1.2.8	NSS/NCC/Phy.Edu. (NG)	--	AE2.8	Surveying and Leveling	3(1+2)	
			AE2.9	NSS-II/NCC-II/Phy. Edu.	1(0+1)	
Total		**21(14+7)**	**Total**		**21(11+10)**	
Semester-III						
HBS-2.1.1	Engineering Mathematics - II	2+1=03	AE3.1	Basic Electrical Gadgets and Instrument	3(2+1)	
HBS-2.1.2	Introduction to computer Web Designing and Internet Applications	1+1=02	AE3.2	Communication Skills	2(1+1)	
SWE-2.1.3	Fluid Mechanics and Open Channel Hydraulics	2+1=03	AE3.3	Environmental Studies and Disaster Management	3(2+1)	
SWE-2.1.4	Hydrology & Soil and Water Conservation Engg.	2+1=03	AE3.4	Farm Machinery and Equipment	3(2+1)	
FMP -2.1.5	Thermodynamics, Refrigeration and Air Conditioning	2+1=03	AE3.5	Fluid Mechanics and Open Channel Hydraulics	3(2+1)	
FMP -2.1.6	Farm Power Engineering	2+1=03	AE3.6	Fundamentals of Food Processing	3(2+1)	
FMP-2.1.7	Heat and Mass Transfer	2+0=02	AE3.7	Heat and Mass Transfer	2(2+0)	
PE-2.1.8	NSS/NCC/Phy. Edu. (NG)	--	AE3.8	Hydrology & Soil and Water Conservation Engg.	3(2+1)	
SDT-2.1.9	Skill Development Training –I (Non-Credit)	--	AE3.9	NSS-III/NCC-III/Phy. Edu.*	NG	
Total		**19(13+6)**	**Total**		**22(15+7)**	

Semester-IV						
HBS-2.2.1	Environmental Science & Disaster Management	2+1=03	AE4.1	Agricultural Informatics and Artificial Intelligence	3(2+1)	
SWE-2.2.2	Strength of Materials	1+1=02	AE4.2	Drying and Storage Engineering	3(2+1)	
SWE-2.2.3	Irrigation Technology	2+1=03	AE4.3	Farm Power	3(2+1)	
SWE-2.2.4	Ground Water and Drainage Engineering	2+1=03	AE4.4	Ground Water and Drainage Engineering	3(2+1)	
FMP-2.2.5	Theory of Machines	2+0=02	AE4.5	Irrigation Technology	3(2+1)	
FMP-2.2.6	Farm Machinery and Implements	2+1=03	AE4.6	Refrigeration and Air-Conditioning	2(1+1)	
PFE-2.27	Post-Harvest Technology	2+1=03	AE4.7	Renewable Energy Sources	3(2+1)	
REE-2.2.8	Non-Conventional Energy Sources	2+1=03	AE4.8	Theory of Machines	2(2+0)	
PE-2.2.9	NSS/NCC/Phy. Edu. (NG)	--	AE4.9	NSS-IV/NCC-IV/Phy. Edu.*	NG	
Total		**22(15+7)**	**Total**		**22(15+7)**	
Semester-V						
HBS-3.1.1	Entrepreneurship Development & Business Management	2+1=03	AE5.1	Computer Programming and Data Structures	2(0+2)	
SWE-3.1.2	Watershed Management	2+1=03	AE5.2	Entrepreneurship Development and Business Communication	3(2+1)	
FMP-3.1.3	Farm Tractor Systems and Controls	2+1=03	AE5.3	Micro Irrigation System Design	3(2+1)	
PFE -3.1.4	Agricultural Process Engineering	2+1=03	AE5.4	Post-Harvest Engineering	3(2+1)	
PFE -3.1.5	Agricultural Structures	2+1=03	AE5.5	Tractor Systems and Controls	3(2+1)	
	Elective – I	2+1=03		Elective – I	3(2+1)	
	Elective – II	2+1=03		Elective – II	3(2+1)	
SDT-3.1.14	Skill Development Training-II (Non--Credit)	--				
		21(14+7)			**20(12+8)**	
Semester-VI						
ITP-3.2.1	Industrial Training cum Project Work	0+18=18	AE6.1	Industrial Training and Experience	20(0+20)	
ST-3.2.2	Study tour (Non-Credit)	--	AE6.2	Study Tour#	NG	
Total		**18(0+18)**	**Total**		**20(0+20)**	

Summary of Credit Hours

Sem-I	Sem-II	Sem-III	Sem-IV	Sem-V	Sem-VI	Total
17(10+7+2*)	21(11+10)	22(15+7)	22(15+7)	20(12+8)	20(0+20)	122(63+59+2*)

* Non Gradial courses
**Tutorial
#Study Tour can be conducted for 7 days separately or in a single stretch
Total Number of Gradial Courses (Compulsory + Electives) = 38+2
Total Number of Non-Gradial Courses = 4
Each class (contact hour) will be of 50 min duration and one practical will be of two contact hours.

Annexure-II
Detailed Syllabi of Polytechnic in Agricultural Engineering (w.e.f. 2025-26)

Semester-I

AE1.1	***Deeksharambh* (Induction-cum-Foundation Course)**	**NG (0+2*)**

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

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

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

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

AE1.2	**Applied Chemistry**	**3(2+1)**

Theory

Unit 1: Importance and scope of chemistry, laws of chemical combination, Dalton's atomic theory: concept of elements, atoms and molecules. Atomic and molecular masses mole concept and molar mass:

Unit 2: States of matter: Gases and liquids three states of matter. Intermolecular interactions, type of bonding. Role of gas laws in elucidating the concept of the molecule, Boyle's law, Charles law, Gay Lussac's law. Ideal behaviour, empirical derivation of gas equation. Ideal gas equation. Liquid State–Vapour pressure, viscosity and surface tension (qualitative idea only, no mathematical derivations).

Unit 3: Structure of atom: Discovery of electron, proton and neutron; atomic number, isotopes and isobars. Rutherford's model and its limitations, Bohr's model and its limitations, concept of shells and subshells, dual nature of matter and light, de Broglie's relationship,

Pauli's exclusion principle $n + l$ Law and Hund's rule, electronic configuration of atoms.

Unit 4: Periodic table: Significance of classification, modern periodic law and present form of periodic table. Enthalpy: Explanation and definition of term. Ionization enthalpy, electron gain enthalpy, electronegativity, valence.

Unit 5: Redox reactions: Concept of oxidation and reduction, redox reactions, oxidation number, balancing redox reactions, in terms of loss and gain of electrons and change in oxidation number.

Unit 6: Chemical equilibrium: Equilibrium in physical and chemical processes, dynamic nature of equilibrium, law of mass action, equilibrium constant, factors affecting equilibrium, Le Chatelier's principle. Ionic equilibrium: Ionization of acids and bases, strong and weak electrolytes, degree of ionization, ionization of polybasic acids, acid strength, concept of pH. Hydrolysis of salts (elementary idea). Buffer solutions, solubility product, and common ion effect (with illustrative examples.) Handerson equation.

Unit 7: Surface chemistry: Adsorption – physisorption and chemisorption; factors affecting adsorption of gases on solids; catalysis: homogenous and heterogeneous, activity and selectivity. Colloids:types, properties and distinction between true solutions, colloids and suspension.

Practical

1. Determination of melting point of an organic compound. (p-toludine, naphthalene, oxalic acid, β-naphthol, resorcinol, benzoic acid.)
2. Determination of boiling point of an organic compound. (acetone, methyl acetate, acetic acid, xylene (o,m,p), water)
3. Determination of pH of some solutions obtained from fruit juices, varied concentrations of acids, bases and salts using pH paper or universal indicator.
4. Study the pH change in the titration of a strong base using universal indicator.
5. Study of pH change by common ion effect in case of weak acids and bases.
6. Determine the strength of a given solution of sodium hydroxide with the help of a standard solution of oxalic acid.
7. Investigation of the foaming capacity of different washing soaps and the effect of addition of sodium carbonate on them.
8. Study of the acidity of different samples of the tea leaves.
9. Determination of the rate of evaporation of different liquids.
10. Analysis of fruit and vegetable juices for their acidity.

Suggested Readings

1. A Text Book of Physical Chemistry By O P Tandon and A S Singh G R Bathala Publications Pvt Limited, New Delhi
2. A Text Book of Organic Chemistry By O P Tandon G R Bathala Publications Pvt Limited, New Delhi
3. A Text Book of Inorganic Chemistry By O P Tandon G R Bathala Publications Pvt Limited, New Delhi
4. A Text Book of Numerical Chemistry By P Bahadur G R Bathala Publications Pvt Limited, New Delhi
5. A text book of Engineering Chemistry by S. S. Dara, S. Chand & Co. New Delhi.
6. Engineering Chemistry by M. M. Uppal& S.C. Bhatia, Khanna Publishers. New Delhi.

7. A Textbook of organic chemistry B.S. Bahl & ArunBahl S. Chand & Co., New Delhi.
8. A Textbook of organic chemistry P.L. Soni S. Chand & Co., New Delhi.
9. A Textbook of organic chemistry O.P. Agrawal Krishna Prakashan
10. A Textbook of organic chemistry Bahl & Tuli S. Chand & Co., New
11. Chemistry of Engineering Materials by C.P. Murthy, C. V. Agarwal and A. Naidu B. S. Publication Hyderabad
12. Engineering Chemistry by J. C. Kuriacose and J. Rajaram, Tata McGraw-Hill Co. New-Delhi.

AE1.3	Applied Mathematics	3(3+0)

Theory

Co-ordinate Geometry:

Point & Triangle: Coordinate systems, Study of point in coordinate system, Distance formula, Mid-point, Area and Centroid of a triangle and Locus of a point.

Straight Line: Equation of straight lines in various form (Slope point form, Two point form, Intercept form), Angle of intersection of lines and Parallel and Perpendicular lines.

Circle: General equation of circle and its characteristics, Centre and radius form, Tangent and Normal and related problems. .

Permutations and Combinations: Definition of Permutations and Combinations, Value of ${}_nP_r$ and ${}_nC_r$, its properties and simple problems.

Binomial theorem: Binomial theorem (without proof) for positive integral index (expansion and general term); Binomial theorem for any index (expansion only) first and second binomial approximation with application to engineering problems.

Logarithm: General properties & Rules of logarithms, Calculations of engineering problems using log tables.

Trigonometry: Units of angles (degree and radian), Allied & Compound angles, Addition and Subtraction formulae, Graph of Sine and Cosine, Multiple and Sub-multiple angles, Transformation of Product into a sum or difference and vice versa, Periodic function, Sum and factor formulae, Inverse trigonometric function, Solution of triangles.

Complex Numbers: Definition, Real and Imaginary parts of a complex number, Polar and Cartesian representation of a complex number and conversion from one form to the other, Conjugate of a complex number, modulus and argument of a complex number, Addition, subtraction, multiplication and division of a complex number.

Statistics and Probability: Measurement of central tendency (Mean, Median and Mode), Measurement of dispersion (Standard deviation), Definition and laws on probability, Probability distribution (Binomial, Poisson and Normal).

Suggested Readings

1. Applied Mathematics Vol. I by SS Sabharwal and Others by Eagle Prakashan, Jalandhar
2. Applied Mathematics Vol. II by SS Sabharwal and Others by Eagle Prakashan, Jalandhar
3. Engineering Mathematics Vol. I by Ishan Publishing House
4. Engineering Mathematics Vol. I by S Kohli and Others; IPH, Jalandhar
5. Engineering Mathematics by Dass Gupta
6. Advanced Engineering Mathematics by AB Mathur and VP Jagi; Khanna Publishers, Delhi
7. Higher Engineering Mathematics by BS Grewal; Khanna Publishers, Delhi

8. Engineering Mathematics by C Dass Chawla; Asian Publishers, New Delhi
9. NCERT 11th and 12th science Mathematics book.

AE1.4	Applied Physics	3(2+1)

Theory

Units and Dimensions: Physical quantities, Fundamental and derived units, Systems of units (FPS, CGS, MKS and SI units), Dimensions and dimensional formulae of physical quantities (area, volume, velocity, acceleration, momentum, force, impulse, work, power, energy, surface, tension, coefficient of viscosity and strain), Dimensional equations and their applications, conversion from one unit to another unit for density, force, pressure, work, power, energy, velocity, acceleration, Limitations of dimensional analysis

Force and Motion: Scalar and vector quantities - examples, addition and multiplication (scalar product and vector product) of vectors, Force, resolution and composition of forces - resultant, parallelogram law of forces, Equilibrium of forces, Lami's theorem, Newton's Laws of motion - concept of momentum, Newton's laws of motion and their applications, determination of force equation from Newton's second law of motion; Newton's third law of motion conversion of momentum, impulse and impulsive forces, simple numerical problems based on third law. Projectile, horizontal and oblique projections and equation of trajectory, Derivation of time of flight, maximum height and horizontal range, Circular motion, Relation between linear and angular velocity and linear acceleration and angular acceleration, Centripetal force (derivation) and centrifugal force, Definitions of torque, moment of inertia, radius of gyration, Conservation of angular momentum (qualitative), Theorems of parallel and perpendicular axes.

Work, Power and Energy: Work: definitions and its SI units, Work done in moving an object on horizontal and inclined plane, (incorporating frictional forces), Power: definitions and its SI units, calculation of power in simple cases, Energy: Definitions and its SI units: Types: Kinetic energy and Potential energy, with examples and their derivation, Principle of conservation of mechanical energy (for freely falling bodies), transformation of energy from one form to another

Magnetism and Matter: Introduction, The Bar Magnet, Current Loop as a Magnet and its Magnetic Moment, Magnetism in Matter, Equivalence between a bar magnet and a solenoid, Gauss's Law for Magnetic Field, The magnetism of Earth and Magnetic Elements, Magnetization and Magnetic Intensity, Magnetic Flux, Absolute and Relative Permeability, Magnetic Susceptibility

Waves and vibrations: Generation of waves by vibrating particles, Wave motion with examples, Types of wave motion, transverse and longitudinal wave motion with examples, Velocity, frequency and wave length, Sound and Light waves

Ray Optics: Introduction, Reflection by spherical mirrors, Relation between focal length and radius of curvature, Spherical mirror formula, Lateral magnification, Refraction of light (Laws of refraction, refraction through compound slab, lateral shift, real depth and virtual depth), Total internal reflection, Spherical lenses (Lens-Maker's formula, magnification, power of lense), Refraction, dispersion and scattering of light.

Gravitation and satellites: Kepler's law of planetary motion, Newton's law of gravitation, Escape velocity (derivation), Satellites, Geostationary satellite.

Practical

To find the thickness of wire using a screw gauge. To find volume of solid cylinder and hollow cylinder using a Vernier caliper. To determine the thickness of glass strip and radius of curvature of a concave surface using a spherometer. By doing suitable experiment, draw the forward bias characteristic curve of a junction diode and determine its forward resistance. By performing an experiment, draw the characteristic curve of the given zener diode and determine its breakdown voltage. To draw the I-V characteristic curves of a p-n junction diode in forward bias and reverse bias.

Suggested Readings

1. Basic Applied Physics by RK Gaur; Dhanpat Rai Publications
2. Applied Physics Vol. I, TTTI Publication Tata McGraw Hill, Delhi
3. Comprehensive Practical Physics - Volume I and II by IN Jaiswal; Laxmi Publishers
4. Numerical Problems in Physics - Volume I and II by RS Bharaj; Tata McGraw Hill
5. Simple Course in Electricity and Magnetism by CL Arora; S Chand and Co, New Delhi
6. Fundamental Physics - Volume I and II by Gomber and Gogia; Pardeep Publications, Jalandhar
7. A Text Book of Optics by Subramanian and Brij Lal
8. Physics Laboratory Manual by PK Palanisamy, Scitech Publications
9. Fundamentals of Physics by Resnick and Halliday, Asian Books Pvt. Ltd., New Delhi
10. Concepts in Physics by HC Verma; Bharti Bhawan Ltd., New Delhi.

AE1.5	English	2(1+1)

Theory:

Passages for Comprehension:-The Language of Science, My Thousandth Goal, New Wonders in Cameras, Rip Van Winkle Comes to Town, Safety Practices, The Robotic Revolution, and Entrepreneurship.

Grammar:-Tenses, Voice-Change, Direct/Indirect narration, Prepositions, Determiners.

Composition: Letter (Formal and Informal), Paragraph Writing, Précis writing, Comprehension of unseen Passage.

Tutorial

Practice on various topic of theory items.

Suggested Readings

1. Bridge intensive course by B. J. Carrol (Oxford Uni. Press)
2. Modern English Grammar by N. Krishnaswamy (Maemilan)
3. Spoken English for India by Bansal & Harrison
4. Developing Programmes and Materials for Language Learning by Fraida Dubin & Elite Olshtain
5. Communicative Approach to Language Teaching by David H. Wyatt
6. "Communication skills for Technical students" Compiled by CDC, TTTI, Bhopal. Published by Somaiya Publications Pvt. Ltd. 4th Revised Edition, July, 1995.

AE1.6	Farming Based Livelihood Systems	3(2+1)

Theory

Status of agriculture in India and different states, Income of farmers and rural people in India, Livelihood-Definition, concept and livelihood pattern in urban and rural areas, Different approaches and framework, Definition of farming systems and farming based livelihood systems Prevalent Farming systems in India contributing to livelihood. Types of traditional and modern farming systems. Components of farming system/ farming-based livelihood systems- Crops and cropping systems, Livestock production, Horticultural crops, Agro--forestry systems, Small-, medium- and large-enterprises including value chains and secondary enterprises as livelihood components for farmers, Commercial farming-based livelihood models by NABARD, ICAR; Case studies on different livelihood enterprises associated with the farming. Risk and success factors in farming-based livelihood systems, Schemes and programs by Central and State Government. Role of farming- based livelihood enterprises in 21st Century in view of circular economy, green economy, climate change, digitalization and changing life style.

Practical

Demonstration of farming systems and agricultural based livelihood enterprises; Study of production and profitability of crop based model, Study of production and profitability of livestock based model, Study of production and profitability of food processing based livelihood models, Study of production and profitability of farming based livelihood models; Field visit of innovative farming system model; Visit of Agri-based enterprises and study of their functional aspects; Study of agri-enterprises involved in industry and service sectors (Value Chain Models), Project concept formulation on farming-based livelihood systems along with cost and profit analysis, Case study of Start-Ups in agri-sectors.

Suggested Readings

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

AE1.7	Workshop Technology and Practice	2(0+2)

Practical

Introduction about different shops in the workshop; Safety and precautions to be taken in the workshop;

Study of different tools used for fitting and different fitting operations; Study of various measuring instruments used for fitting; Demonstration of fitting: sawing, filing and right angle fitting of MS flat; working with complex fitting jobs: operations of drilling, reaming, and threading and with tap dies; Preparation of a paper weight;

Study of various carpentry tools, types of wood and their characteristics and working with carpentry tools; Demonstration of preparing of simple joints in carpentry: cross half lap joint or T-half joint, Mortise and Tenon joint in carpentry; Preparation of dovetail joint in carpentry;

Study of welding, types of welding, oxyacetylene gas welding, types of flames, welding techniques and equipment used for gas welding, working with welding equipment; Working with electric arc welding; Equipment and tools, safety and precautions taken in arc welding; Preparation of Butt joint and lap joint with ARC welding;

Working on a lathe machine and study of different tools used in lathe machine; Demonstration of simple turning, step turning in lathe machine; Preparation of job on taper turning, drilling, knurling and threading in lathe machine;

Working with different machines in machine shop such as shaper, milling machine, etc. and with different tools used in machine shop; Demonstration on bending, shaping etc.; Exercise on Drawing, Punching, Riveting; Making different types of sheet metal joints using G.I. sheets.

Suggested Readings

1. Chapman W A J. 2018. Workshop Technology (Vol. I and II). Arnold Publishers (India) Pvt. Ltd., AB/9, Safdarjung Enclave, New Delhi.
2. Hajra Choudhury S K, Roy N, Hajra Choudhury A K. 2017. Elements of Workshop Technology (Vol. I and II). Media Promoters and Publishers Pvt. Ltd, Mumbai.
3. Khurmi R S and Gupta J K. 2018. A Text Book of Workshop Technology. S. Chand & Company Ltd, New Delhi.
4. Raghuwansi B S. 2016. A Course in Workshop Technology (Vol. I and II). Dhanpat Rai and Sons, 1682, Nai Sarak, New Delhi.

AE1.8	NSS-I/NCC-I/Phy. Edu.	1(0+1)

Practical/ Awareness activities

- Arms Drill- Attention, stand at ease, stand easy. Getting on parade. Dismissing and falling out. Ground/take up arms, examine arms. Shoulder from the order and vice- versa, present from the order and vice-versa. Saluting at the shoulder at the halt and on the march. Short/long trail from the order and vice- versa. Guard mounting, guard of honor, Platoon/Coy Drill.
- Characteristics of rifle (.22/.303/SLR), ammunition, fire power, stripping, assembling, care, cleaning, and sight setting. Loading, cocking, and unloading. The lying position and holding.
- Trigger control and firing a shot. Range Procedure and safety precautions. Aiming and alteration of sight. Theory of groups and snap shooting. Firing at moving targets. Miniature range firing. Characteristics of Carbine and LMG.

- Introduction to map, scales, and conventional signs. Topographical forms and technical terms.
- The grid system. Relief, contours, and gradients. Cardinal points and finding north. Types of bearings and use of service protractor. Prismatic compass and its use. Setting a map, finding north and own position. Map to ground and ground to map. Knots and lashings, Camouflage and concealment, Explosives and IEDs.
- Field defenses obstacles, mines and mine lying. Bridging, waterman ship. Field water supplies, tracks and their construction. Judging distance. Description of ground and indication of landmarks. Recognition and description of target. Observation and concealment. Field signals. Section formations. Fire control orders. Fire and
- Orientation: history, objectives, principles, symbol, badge; regular programmes under NSS
- Organizational structure of NSS, Code of conduct for NSS volunteers, points to be considered by NSS volunteers' awareness about health.
- NSS programme activities. Concept of regular activities, special camping, day camps, basis of adoption of village/slums, conducting survey, analyzing guiding financial patterns of scheme, youth programmes/ schemes of GOI, coordination with different agencies and maintenance of diary. Understanding youth. Definition, profile, categories, issues and challenges of youth; and opportunities for youth who is agent of the social change.
- Community mobilization. Mapping of community stakeholders, designing the message as per problems and their culture; identifying methods of mobilization involving youth- adult partnership. Social harmony and national integration
- Indian history and culture, role of youth in nation building, conflict resolution and peace-building. Volunteerism and shramdaan. Indian tradition of volunteerism, its need, importance, motivation, and constraints; shaman as part of volunteerism
- Citizenship, constitution, and human rights. Basic features of constitution of India, fundamental rights and duties, human rights, consumer awareness and rights and rights to information. Family and society. Concept of family, community (PRIs and other community-based organizations) and society movement. Movement with/without arms. Section battle drill. Types of communication, media, latest trends and developments.

Semester-II

AE2.1	**Crop Production and Protection Technology**	**3(2+1)**

Theory

Introduction and scope of agronomy; Classification of crops; Effect of different weather parameters on crop growth and development; Crop seasons; Time and method of sowing of major field crops, seed rate for important crops; Methods and time of application of manures and fertilizers, fertigation; Weeds and their management in crops; Crop rotation, cropping systems, cropping scheme, relay cropping, mixed cropping and intercropping. Soil forming processes; Classification and composition of soil, soil taxonomy orders; Important soil physical properties and their importance; soil particle distribution; soil inorganic colloids– their composition, properties and origin of charge; ion exchange in soil and nutrient availability; soil organic matter– its composition and decomposition, effect on soil fertility; Essential plants nutrients- their functions and deficiency symptoms in plants; Important inorganic fertilizers and their reactions in soils. Types of horticultural crops; Sowing and planting

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

Practical

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

Suggested Reading

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

AE2.2	Engineering Chemistry	2(1+1)

Theory

Definition of corrosion; Types of corrosion; Factors affecting the rate of corrosion; Methods of prevention of corrosion. Definition of fuels; classification of fuels; Calorific value and its unit; Combustion-chemical reaction. Lubricants: properties, mechanism, classification. Introduction and

Definition of Polymer and Monomer; Classification of Polymer on basis of Molecular structure as Linear, Branch and Cross-linked polymers; Classification on basis of monomers (homopolymer and copolymer); Classification of Polymers on basis of Thermal behaviour (Thermoplastics& Thermosetting).

Practical

To study the different types of fuels. To do comparative study of fuel characteristics. To study the different properties of lubricants, Viz.Pour Point. To study the different properties of lubricants, Viz. Flash Point. To determine Viscosity of Liquid Lubricants. To study the Oxidative resistance of Lubricant. Determination of viscosity of oil.

Suggested Readings

1. Bahl, B.S., Bahl, A. and Tuli, B.D. 2007. Essentials of Physical Chemistry. S. Chand and Co. Ltd, Delhi.
2. Finar, I.L. 2002. Organic Chemistry. Vol I and II.
3. Pearson.Glasstone, S. Elements of Physical Chemistry. The Macmillan Company of India Limited.

AE2.3	Engineering Drawing	2(0+2)

Practical

Uses of drawing aids: Drawing equipment instruments and materials, Construction of Polygons. Lines, lettering & dimensioning : Different types of lines, Vertical capital & lower case letters, Inclined capital & lower case letters, Dimensioning methods–aligned method & unilateral with chain, parallel, progressive & combined dimensioning projections of points, lines & planes : Reference planes, orthographic projections, 1st Angle and 3rd Angle Projections of points, Projections of Lines–determination of true lengths & inclinations, Projections of plane–determination of true shape, orthographic projections :Front view, Top view, Side view, Bottom view & rear view isometric projections : Difference between isometric projections & isometric drawing. Isometric views & isometric projections. Fasteners :Detachable & permanent fasteners–difference, Sketches of elements of screw threads, Sketches of thread forms–B.S, B.A, Square with worth, Acme with Knuckle, Buttress–Seller Unified., Internal & external threads, Left hand & right hand threads, Single & multi start threads, Lead & pitch, Sketches of studs, cap screws machine screws, set screws, Locking devices, bolts, hexagonal & square nuts & nut bolt & washer assembly. Sketches of various types of rivet heads (snap–pan–conical–countersunk) Sketches of keys (sunk, flat, saddle, gib head, woodruff), Sketches of hole & shaft Assembly.

Suggested Reading

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

AE2.4	Engineering Mathematics	3(3+0)

Theory

Determinants: Expansion of determinants (upto third order) using Sarrus rule, Expansion method and pivotal's condensation method. Properties of determinants, Solution of equations (upto 3 unknowns) by Cramer's rule.

Matrices: Definition of matrix, addition, subtraction and multiplication of matrices (up to third order). Inverse of a matrix by adjoint method, Solution of equations (up to 3 unknowns) by matrix method.

Function: Definition and concept of function, Examples.

Limit: Concept of limit, Standard formulae & working rules of limits and related example

Differentiation: Definition, Differentiation by first principle method, Rules of Sum, Product & Quotient of Functions, Chain Rule, Differentiation of Sum, Product & Quotient of different functions, Derivative of Implicit functions and Parametric functions, Substitution method, Logarithmic differentiation. Successive differentiation up to second order, Example related application of derivatives.

Integration: Concept, Integral of standard functions, Working rules of integration, Integration by parts, Integration by substitution method, Integration by partial fraction method, Definite Integral and its properties, Application of definite integral to find area, Double and triple integrals, Volume and surface revolution curves.

Vectors: Definition of vector and scalar quantities. Addition and subtraction of vectors. Dot product and Cross product of two vectors. Thumb rule. Angle between two vectors, Application of dot and cross product in engineering problems, Scalar triple product and vector triple product.

Functions of a Complex Variable: Limit, Continuity and derivative of complex functions, Analytic function, Cauchy-Reimann equations, Conjugate functions, Harmonic functions.

Suggested Readings

1. Applied Mathematics Vol. I by SS Sabharwal and Others by Eagle Prakashan, Jalandhar
2. Applied Mathematics Vol. II by SS Sabharwal and Others by Eagle Prakashan, Jalandhar
3. Engineering Mathematics Vol. I by Ishan Publishing House
4. Engineering Mathematics Vol. I by S Kohli and Others; IPH, Jalandhar
5. Engineering Mathematics by Dass Gupta
6. Advanced Engineering Mathematics by AB Mathur and VP Jagi; Khanna Publishers, Delhi
7. Higher Engineering Mathematics by BS Grewal; Khanna Publishers, Delhi
8. Engineering Mathematics by C Dass Chawla; Asian Publishers, New Delhi
9. NCERT 11th and 12th science Mathematics book.

AE2.5	Engineering Mechanics	2(1+1)

Theory

Equilibrium of forces, free body diagrams, Centre of gravity (CG) of simple geometrical figures, CG by moments, plane figures, axis of references, CG of symmetric sections, unsymmetrical sections, solid bodies and cut sections; Moment of inertia: methods of finding out M.I.

Frictional forces, static friction, dynamic friction, limiting friction, normal reaction, angle of friction, coefficient of friction, laws of friction, equilibrium of a body lying in horizontal and inclined planes;

Simple stresses and strain, Hooke’slaw, Poisson’s ratio, modulus of elasticity, Strain related problems

Shear force and bending moment, fundamentals of shear force and bending moment, SFD and BMD

of cantilever and simply supported and overhanging beams, point of contra-flexure; Torsion of circular shaft, torsional effect, hoop stress, power transmitted by a shaft; Mohr's circle.

Practical

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

Suggested Reading

1. Bansal, R. K. 2005. A Text Book of Engineering Mechanics. Laxmi Publishers, New Delhi.
2. Khurmi, R. S. 2006. Strength of Materials. S. Chand Publishing.
3. Khurmi, R. S. 2018. A Text Book of Engineering Mechanics. S. Chand Publishing.
4. Prasad, I. B. 2004. Applied Mechanics and Strength of Materials. Khanna Publishers, New Delhi.
5. Prasad, I. B. 2004. Applied Mechanics. Khanna Publishers, New Delhi.
6. Sundarajan, V. 2002. Engineering Mechanics and Dynamics. Tata McGraw Hill Publishing Co. Ltd, New Delhi.
7. Timoshenko, S. and Young, D. H. 2003. Engineering Mechanics. McGraw Hill Book Co., New Delhi.

AE2.6	**Engineering Physics**	**2(1+1)**

Theory

Dia, Para and ferromagnetism-classification. Langevin theory of dia and paramagnetism. Adiabatic demagnetization. Weiss molecular field theory and ferromagnetism. Curie-Weiss law. Wave particle quality, de- Broglie concept, uncertainty principle. Wave function. Time dependent and time independent Schrodinger wave equation, Qualitative explanation of Zeeman Effect, Stark effect and Paschan Back effect, Raman spectroscopy. Statement of Bloch's function. Bands iii solids, velocity of Bloch's electron and effective mass. Distinction between metals. Insulators and semiconductors. Intrinsic and extrinsic semiconductors, law of mass action. Determination of energy gap in semiconductors. Donors and acceptor levels. Superconductivity, critical magnetic field. Meissner effect. Isotope effect. Type-I and II superconductors, Josephson's effect DC and AC, Squids. Introduction to high Tc superconductors. Spontaneous and stimulated emission, Einstein A and B coefficients. Population inversion, He-Ne and Ruby lasers. Ammonia and Ruby masers, Holography-Note. Optical fibre. Physical structure. Basic theory. Mode type, input output characteristics of optical fibre and applications. Illumination: laws of illumination, luminous flux, luminous intensity, candle power, brightness.

Practical

To find the frequency of A.C. supply using an electrical vibrator. To find the low resistance using Carey Foster bridge without calibrating the bridge wire. To determine dielectric constant of material using De Sauty's bridge. To determine the value of specific charge (e/m) for electrons by helical method. To study the induced e.m.f. as a function of velocity of the magnet. To obtain hysteresis curve (B-H curve) on a C.R.O. and to determine related magnetic quantities. To study the variation of magnetic field with distance along the axis of a current carrying circular coil and to detuning the radius of the coil. To determine the energy band gap in a semiconductor using a p-n Junction diode. To determine the slit width from Fraunhofer diffraction pattern using laser beam. To find the numerical aperture of optical fiber. To set up the fiber optic analog and digital link. To study the phase relationships in L.R. circuit. To study LCR circuit. To study the variations of thermo emf of a copper-constantan thermo-couple with temperature. To find the wave length of light by prism.

Suggested Readings

1. Text Book of optics. Brijlal and Subrahmanyam by S. Chand and Co., New Delhi.
2. Optical State Physics and Fiber Optics by Sarkar Subir Kumar. S. Chand and Co., New Delhi.
3. Elements of Spectroscopy by Gupta S L, Kumar V Sharma R C. Pragati Prakasam, Meeruth.
4. Solid State Physics by Saxena B S and Gupta R C. Pragati Prakasam, Meeruth.
5. Essentials of Quantum Mechanics by Srivastava B N. Pragati Prakasam, Meeruth.
6. Fundamentals of Magnetism and Electricity by Vasudeva D N. S. Chand and Co., New Delhi.

AE2.7	General Microbiology	3(2+1)

Theory

Scope and history of microbiology: (notable contributions of Leeuwenhoek, Pasteur, Koch, etc.); Groups of microorganisms; Applied area of microbiology, Classification and identification of micro-organism; Major Characteristics of Microorganisms. Microscopy: Introduction to microscope; Component of microscope; Structures external to cell wall, Cell wall; Structures internal to cell wall. Cultivation and preservation of micro-organisms: Nutritional requirements; Types of media. Physical condition required for the growth; Enumeration methods for micro-organisms. Bacterial Metabolism and Growth: Reproduction of bacteria; Growth of bacteria: growth curve, Control of microorganisms: Physical and Chemical agents.

Practical

To study Microscopy; Micrometry; Sterilization of glassware and acquainting with equipment used in microbiology; To prepare of nutrient agar media and techniques of inoculation; To study Staining methods (gram staining, negative staining); To study Pure culture techniques (streak plate/pour plate/spread plate); Identification procedures (morphology and cultural characteristics); To study Growth characteristics of fungi: To determine microbial numbers, direct plate count, generation time.

Suggested Readings

1. Pelczar Jr. M.J., Chan, E.C.S. and Krieg, N.R. 1998. Microbiology. 5th edn. Tata McGraw-Hill Education, New Delhi.

2. Tortora, G.J., Funke, B.R. and Case, C.L. 2014. Microbiology: An Introduction. 12th edn. Prentice-Hall, NY, USA.
3. Willey, J.M., Sherwood, L.M. and Woolverton, C.J. 2013. Prescott's Microbiology. 9th edn. McGraw-Hill Higher Education, NY, USA.

AE2.8	Surveying and Levelling	3(1+2)

Theory

Surveying: Introduction, classification and basic principles, linear measurements. Chain surveying. Cross staff survey, Compass survey. Planimeter, Errors in measurements, their elimination and correction. Plane table surveying. Levelling, Levelling difficulties and error in levelling, Contouring, Computation of area and volume. Theodolite traversing. Introduction to setting of curves. Total station, Electronic Theodolite. Introduction to GPS survey.

Practical

Chain survey of an area and preparation of map. Compass survey of an area and plotting of compass survey. Plane table surveying. Levelling. L section and X sections and its plotting. Contour survey of an area and preparation of contour map. Introduction of software in drawing contour. Theodolite surveying; Ranging by Theodolite, Height of object by using Theodolite; Setting out curves by Theodolite; Minor instruments. Use of total station.

Suggested Readings

1. Surveying (Vol.I) by Punmia, B C 1987. Laxmi Publications, New Delhi.
2. Surveying (Vol.I) by Arora, K R 1990. Standard Book House, Delhi.
3. Surveying and Levelling by Kanetkar, T P 1993. Pune Vidyarthi Griha, Prakashan, Pune.

AE2.9	NSS-II/NCC-II/Phy. Edu.	1(0+1)

Practical/ Awareness activities

- Importance and role of youth leadership
- Meaning, types and traits of leadership, qualities of good leaders; importance and roles of youth leadership, Life competencies
- Definition and importance of life competencies, problem-solving and decision-making, interpersonal communication. Youth development programmes
- Development of youth programmes and policy at the national level, state level and voluntary sector; youth-focused and youth-led organizations
- Health, hygiene and sanitation. Definition needs and scope of health education; role of food, nutrition, safe drinking water, water borne diseases and sanitation (Swachh Bharat Abhiyan) for health; national health programmes and reproductive health. Youth health, lifestyle, HIV AIDS and first aid. Healthy lifestyles, HIV AIDS, drugs and substance abuse, home nursing and first aid. Youth and yoga. History, philosophy, concept, myths, and misconceptions about yoga; yoga traditions and its impacts, yoga as a tool for healthy lifestyle, preventive and curative method.

Semester-III

AE3.1	Basic Electrical Gadgets and Instrument	3(2+1)

Theory

Introduction to different electrical appliances used in agricultural buildings, structures and farm operations; AC circuits, line and phase quantity in star and delta network, power in three-phase circuit, various methods of three phase power measurement like (one wattmeter and two –wattmeter method). Diode and its applications: Rectifier, Clipper, Clamper, filter circuits; Transistor and its applications: Bipolar junction transistor, operating point. Various biasing methods; OP-AMP, Ideal OP-AMP characteristics;

Introduction to digital electronics and logic gates: Basic theorem of boolean algebra, combinational logic circuits (basic gates, SOP rule and K-map), binary adder. Principles of general instruments, measurement of displacement, temperature, velocity, force and pressure using different instruments like strain gauges, load cell, thermistors, thermocouples, pyrometer, linear variable differential transformer (LVDT), capacitive transducers, RTD, instruments for measurement of speed, wind velocity, solar radiation, anemometer, multimeter, etc.

Practical

Basic Electrical and Electronics Gadgets

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

Instrumentation

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

Suggested Reading

1. Boylestad R L and Nashelsky L N. 2011. *Electronic Device and Circuit Theory*. Pearson.
2. Ghosh S. 2007. *Fundamentals of Electrical and Electronics Engineering*. Second edition. PHI Learning, New Delhi.

3. Metha V K and Metha R. 2012. *Basic Electrical Engineering*. Fifth edition. S Chand & Co., New Delhi.
4. Metha V K and Metha R. 2012. *Principle of Electronics*. Fifth edition. S Chand & Co., New Delhi.
5. Rajput R K. 2007. *Basic Electrical and Electronics Engineering.* Laxmi Publications, New Delhi.
6. Theraja B L and Theraja A K. 2005. *A Text Book of Electrical Technology.* Vol. I & II. S Chand & Co., New Delhi.
7. Godse, A. P. and Bakshi, U. A. Basic Electronics Engineering. Technical Publications, Pune.
8. Bakshi, Ajay V. and Bakshi, Uday A. Electrical Instrumentation & Process Control. Technical Publications, Pune.

AE3.2	**Communication Skills**	**2(1+1)**

Theory

Communication Process: The magic of effective communication; Building self-esteem and overcoming fears; Concept, nature and significance of communication process; Meaning, types and models of communication; Verbal and non-verbal communication; Linguistic and non-linguistic barriers to communication and reasons behind communication gap/ miscommunication.

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

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

Practical

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

Suggested readings

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

8. Seely, J. 2013. Oxford Guide to Effective Writing and Speaking. Oxford University Press.
9. Thomson, A. J. and Martinet, A. V. 1977. A Practical English Grammar. Oxford University.

AE3.3	Environmental Studies and Disaster Management	3(2+1)

Theory:

Introduction to Environment - Environmental studies - Definition, scope and importance - Multidisciplinary nature of environmental studies - Segments of Environment - Spheres of Earth - Lithosphere - Hydrosphere - Atmosphere - Different layers of atmosphere. Natural Resources: Classification - Forest resources. Water resources. Mineral resources Food resources. Energy resources. Land resources. Soil resources. Ecosystems - Concept of an ecosystem - Structure and function of an ecosystem - Energy flow in the ecosystem. Types of ecosystem. Biodiversity and its conservation: Introduction, definition, types. Biogeographical classification of India. Importance and Value of biodiversity. Biodiversity hot spots. Threats and Conservation of biodiversity Environmental Pollution: Definition, cause, effects and control measures of: a. Air pollution. b. Water pollution. c. Soil pollution. d. Marine pollution. e. Noise pollution. f. Thermal pollution h. light pollution. Solid Waste Management: Classification of solid wastes and management methods, Composting, Incineration, Pyrolysis, Biogas production, Causes, effects and control measures of urban and industrial wastes. Social Issues and the Environment: Urban problems related to energy. Water conservation, rain water harvesting, watershed management. Environmental ethics: Issues and possible solutions, climate change, global warming, acid rain, deozone layer depletion, nuclear accidents and holocaust. Environment Protection Act. Air (Prevention and Control of Pollution) Act. Water (Prevention and control of Pollution) Act. Wildlife Protection Act. Forest Conservation Act. Human Population and the Environment: Environment and human health: Human Rights, Value Education. Women and Child Welfare. Role of Information Technology in Environment and human health.

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

Practical

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

Suggested Readings

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

AE3.4	Farm Machinery and Equipment	3(2+1)

Theory

Introduction:-Importance of farm mechanization, Classification of machinery &implements used in the farm for raising crops

Primary Tillage Equipment: Introduction to various primary tillage implements used on the farm. Functions, constructional details, adjustments and study of different plough viz. mould board plough, disc plough, rotary plough (rotator) and chisel plough.

Secondary Tillage Implements: Introduction to the various secondary tillage implements. Study of cultivators &harrows, their types, functions & constructional details.

Seeding and Planting Equipment: Introduction to various seeding and planting machinery used for various crops. Study of components &functions of seed drills &planters; Concept of minimum tillage technology (Zerotill, striptill drill, bed planters). Calibration of seed drills and planters.

Intercultural Tools, Weeding Tools: Introduction to various tools used for interculture, study of their functions and constructional details. Types of sprayers and dusters, their uses and constructional details.

Fertilizer Manure Application Equipment: Familiarization with the manure spreaders &granular fertilizer spreading equipment, study of their functions and importance. Study of various types of the nozzles used in the sprayers.

Harvesting and Threshing Machinery: Familiarization with the harvesting machines for various crops e. g. hay harvesters, forage harvesters, vertical conveyer reapers, cotton pickers, com harvester, potato diggers, ground nut diggers.

Constructional details & principles of working of thresher: Study of power thresher including axial flow thresher - main components, function and constructional details. Safety requirements in threshing operations. Introduction to combine harvesters and straw combines and study of their operation. Losses during harvesting and threshing operations and their management.

Land Development Machinery: Familiarization with various land development implements e.g. leveler, planer, scraper, ridger. Study of their functions and adaptability.

Practical

To study the constructional features and different components of the following agricultural implements/ farm machines. Primary tillage implements: Mould board plough /Disc plough. Secondary tillage implements: Harrow/Cultivators, Rotavators. Sowing Machines: Seed Drill/Planter/Transplanter, no-till, strip-till drill, bed planter, sugarcane planters, and potato-planter. Interculture equipment/tools: Wheel hand hoe/Cultivators. Harvesting Machines: Vertical Conveyer Reaper/Mower/Potato digger/ Groundnut Digger. Threshing Machines: Wheat/paddy thresher, axial flow thresher, High capacity multicrop thresher. Seed treater, different types of sprayers and dusters.

Suggested Readings

1. Element of Farm Machinery by AC. Srivastava and RajuPrimlari; Oxford &IBH Publishing Co. Pvt Ltd, New Delhi
2. Principle of Farm Machinery by R.A. Kepner, Roy Bainer, and E.H. Barger; CBS Publishers and Distributors, Delhi
3. Elements of Agricultural Engineering Part 1 & 2 by Dr. O.P. Singhal and Naresh Chandra Aggarwal; Mumfordganj, Allahabad
4. Principle of Agricultural Engineering Volume-I by A.M. Michael & T.P. Ojha; Jain brothers.
5. Farm Power Machinery Volume-I by ISAE; Jain brothers
6. Farm Power Machinery & Surveying by Irshad Ali ; KitabMahal, NaiSarak, Delhi
7. Farm Machinery by Smith.

AE3.5	Fluid Mechanics and Open Channel Hydraulics	3(2+1)

Theory

Properties of fluids: Ideal and real fluid. Pressure and its measurement, Pascal's law, pressure forces on plane and curved surfaces, centre of pressure, buoyancy, meta centre and meta centric height, condition of floatation and stability of submerged and floating bodies; Kinematics of fluid flow: Lagrangian and Eulerian description of fluid motion, continuity equation, path lines, streak lines and stream lines, stream function, velocity potential and flow net. Types of fluid flow, translation, rotation, circulation and vorticity, Vortex motion; Dynamics of fluid flow, Bernoulli's theorem, venturimeter, orifice meter and nozzle, siphon; Laminar flow: Stress strain relationships, flow between infinite parallel plates both plates fixed, one plate moving, discharge, average velocity; Laminar and turbulent flow in pipes, general equation for head loss Darcy, Equation, Moody's diagram, Minor and major hydraulic losses through pipes and fittings, flow through network of pipes, hydraulic gradient and energy gradient; Flow through orifices (Measurement of Discharge, Measurement of Time),Flow through Mouthpieces, Flow over Notches , Flow over weirs, Chezy's formula for loss of head in pipes, Flow through simple and compound pipes, Open channel design and hydraulics: Chezy's formula, Bazin's formula, Kutter's Manning's formula, Velocity and Pressure profiles in open channels. Introduction to fluid machinery.

Practical

Study of manometers and pressure gauges. Verification of Bernoulli's theorem. Determination of coefficient of discharge of venturi-meter and orifice meter. Determination of coefficient of friction in pipeline. Determination of coefficient of discharge for rectangular and triangular notch. Determination

of coefficient of discharge, coefficient of velocity and coefficient of contraction for flow through orifice. Determination of coefficient of discharge for mouth piece. Study of current meter.

Suggested Readings

1. A Text Book of Hydraulics, Fluid Mechanics and Hydraulic Machines by Khurmi, R .S. 1970. S. Chand & Company Limited, New Delhi.
2. Hydraulics and Fluid Mechanics by Modi P M and Seth S.M.1973. Standard Book house, Delhi.
3. Open Channel Hydraulics by Chow V T 1983. McGraw Hill Book Co., New Delhi.
4. Fluid Mechanics and Hydraulics by LalJagadish 1985. Metropolitan Book Co.Pvt. Ltd., New Delhi.

AE3.6	Fundamentals of Food Processing	3(2+1)

Theory

Food: Definition and Functions, Classification of foods, sources, types and perishability of foods; Causes and types of food spoilage; Scope and benefit of food preservation. Engineering Properties of Food Materials; physical, thermal, aerodynamic, optical, mechanical, rheological and electromagnetic properties and their measurement. Food processing: Introduction, levels and techniques; Methods of food preservation; Preservation by salt and sugar: Principle, method and effect on food quality. Preservation by heat treatment: Principle, process and equipment for blanching, canning, pasteurization, sterilization. Preservation by use of low temperature: Principle, methods, equipment. Preservation by drying, dehydration and concentration: Non-thermal preservation processes: Principles, equipment – Pulsed electric field and pulsed intense light, ultrasound, dielectric heating, ohmic and infrared heating, high pressure processing, microwave processing, Cold Plasma technology, etc. Quality tests and shelf-life of preserved foods.

Practical

Demonstration of various perishable food items and degree of spoilage; Blanching of selected food items; Preservation of food by heat treatment- pasteurization; Preservation of food by high concentration of sugar: Jam; Preservation of food by using salt: Pickle; Preservation of food by using acidulants i.e. pickling by acid, vinegar or acetic acid; Preservation of food by using chemical preservatives; Preservation of bread, cake using mold inhibitors; Drying of fruit slices pineapple slices, apple slices in cabinet drier; Drying of green leafy vegetables; Drying of mango/ other pulp by foam-mat drying; Drying of semisolid foods using roller dryers; Drying of foods using freeze drying process;

Suggested Readings

1. Brennan, J.G. 2006. Food Processing Handbook. Wiley-VCH Verlag GmbH and Co. KGaA, Weinheim, Germany.
2. Desrosier N.W. and Desrosier, J.N. 1977. The Technology of Food Preservation. 4th edn. AVI Publishing Co., Connecticut, USA.
2. Fellows, P. 2000. Food Processing Technology: Principles and Practice. 2nd edn. CRC Press, Boca Raton, FL, USA.
3. Karel, M. and Lund, D.B. 2003. Physical Principles of Food Preservation. 2nd edn. Marcel Dekker, Inc., NY, USA.

4. Lal, G., Siddappa, G.S. and Tandon, G.L. 1959. Preservation of Fruits and Vegetables. ICAR, New Delhi.
5. Potter, N. N. and Hotchkiss, J.H. 1995. Food Science. 5th edn. Chapman and Hall, NY, USA.
6. Rahman, M.S. 2007. Handbook of Food Preservation. 2nd edn. CRC Press, Boca Raton, FL, USA.
7. Stavros Y. 2008. Solving Problems in Food Engineering. Springer Science + Business Media, NY, USA.

AE3.7	Heat and Mass Transfer	2(2+0)

Theory

Concept, modes of heat transfer, thermal conductivity of materials, measurement, general differential equation of conduction, one dimensional steady state conduction through plane and composite walls, tubes and spheres without heat generation, electrical analogy, insulation materials and fins; Free and forced convection, Newton's law of cooling, heat transfer coefficient in convection, non-dimensional numbers ;equation of laminar boundary layer on flat plate and in a tube, laminar forced convection on a flat plate and tube, combined free and forced convection; Thermal radiation, black body radiation, Stefan-Boltzmann law, black body emissive power, emissivity, absorptivity, reflectivity and transmissivity; Heat transfer analysis involving conduction, convection and radiation; Types of heat exchangers; fouling, log mean temperature difference, heat exchanger performance, transfer units; Heat exchanger analysis restricted to parallel and counter flow heat exchangers; Introduction to mass transfer, analogy between heat and mass transfer, Fick's law of diffusion.

Suggested Readings

1. Transport Port Processes and Unit Operations by Geankoplis C.J. 1978. Allyn and Bacon Inc., Newton, Massachusetts.
2. Heat Transfer by Holman J P. 1989. McGraw Hill Book Co., New Delhi.
3. Fundamentals of Heat and Mass Transfer by Incropera F P and De Witt D P. 1980. John Wiley and Sons, New York.
4. Engineering Heat Transfer by Gupta C P and Prakash R. 1994. Nem Chand and Bros., Roorkee.

AE3.8	Hydrology & Soil and Water Conservation Engineering	3(2+1)

Theory

Introduction: Water resources and their importance. Hydrological cycle. Hydrologic equation and its components. Geohydrological and hydrological balance. Rainfall and its measurement. Factors affecting rainfall. Run off, factors affecting runoff. Estimation of runoff.

Erosion: Definition, Classification of erosion viz. Geological &accelerated. Agents causing erosion. Mechanics of Water Erosion: Raindrop erosion, Sheet erosion, Rill erosion, Gully erosion and principle of gully erosion and Classification of gullies. Stream channel erosion. Effects of water erosion, Factors affecting erosion by water. Mechanics of Wind Erosion: Processes of saltation, suspension, surface creep. Factors affecting erosion by wind.

Erosion Control: Principles of erosion control. Agronomic and field practices to control erosion by wind &water i.e. Contour farming, strip cropping, tillage etc. Terracing to control erosion by water. Types of terraces. Terrace design parameters and planning a terrace system. Bench terraces, types and

design parameters. Use of bunds to control erosion and design parameters of bunds. Contour bunding. Vegetated water ways for the control of erosion.

Practical

To study different instruments at meteorological observatory station. To study the rainfall measurement system. Analysis of rainfall data i.e. intensity, duration, frequency analysis, mean-arial depth of rainfall, measurement and estimation of runoff. To study the various types of soil erosion and their control. To study the terracing and bunds for soil erosion control. To study the vegetative water ways for the control of erosion and safe disposal of water.

Suggested Readings

1. Soil & Water Conservation Engineering by Glenni O. Schwav, Richard K.
2. Frevert, Talcott W. Edminster, Kenneth K. Barnes; John Wiley & Sons New York
3. Manual of Soil & Water Conservation Practice by Gurmail Singh; Oxford & IBH Publication co.
4. Soil & Water Conservation Engineering by Suresh R.; Standard Publication
5. Principle of Agricultural Engineering Volume-II by A.M. Michael & T.P. Ojha; Jain brothers.
6. Hydraology: Principles analysis and design (Revised II Edition) Raghunath, H.M. 2006. New Age International, Pvt. Ltd., Publishers, New Delhi.
7. Engineering Hydrology (III Edition) by K Subramaniya. 2008. Tata McGraw Hill Publishing Co, New Delhi
8. Watershed Hydrology by Suresh R.; Standard Publication
9. Land and water management engineering (IV edition) by VVN Murthy. Kalyani Publishers, New Delhi.

Semester-IV

AE4.1	Agricultural Informatics and Artificial Intelligence	3(2+1)

Theory

Fundamentals of computers, Analogy of computers, memory concepts; Operating systems : definition and types ; Application of MS-Office in data handling like creating, editing, formatting document ; Data presentations ; Tabulation, Graph creation ; Introduction to DBMS and Internet, Web designing, DBMS in agriculture ; Application of information communication technology in agriculture, concepts and different applications ; Introduction to computer programming ; General concepts and different computer programming languages ; Introduction to artificial intelligence and its applications in agriculture : concepts, techniques and applications

Practical

Study of computer components, accessories, practice of important DoS Commands, Introduction of different operating systems such as Windows, Unix/ Linux, creating files and folders, File Management. Use of MS-WoRD and MS Power-point for creating, editing and presenting a scientific documents, MS- EXCEL - Creating a spreadsheet, Use of statistical tools, Writing expressions, Creating graphs, Analysis of scientific data, Handling macros. MS-ACCESS: Creating Database, preparing queries and reports, Demonstration of Agri- information system, Introduction to World Wide

Web (WWW) and its components, Study of ICT tools and computer models for various agricultural applications.

Suggested Readings

1. Choudhary K. R. Fundamentals of Artificial Intelligence. Springer
2. Date, C. J. 2000. Introduction to Database Management System. Addison-Wesley.
3. Kumar, E. 2020. Artificial Intelligence. Wiley.
4. Nilson, N.J. 2001. Principles of Artificial Intelligence. Narosa.
5. Rajaraman, V. and Adabala, N. Fundamentals of Computers. PHI Learning Pvt. Ltd, New Delhi.
6. Russell, Stuart. 2013. Artificial Intelligence: A Modern Approach. Pearson Edition.
7. Sethi, D. P. and Pradhan, M. 2017. Concepts and Techniques of Programming in C. I.K. International Publishing House Pvt. Limited.

AE4.2	Drying and Storage Engineering	3(2+1)

Theory

Introduction; Water Activity; Water binding and its effect on enzymatic and non-enzymatic reactions and food texture, control of water activity and moisture.

Drying of Cereals and Pulses: Thermal properties - Specific heat - Thermal Conductivity - Thermal diffusivity. Theory of grain drying - Thin layer drying - Moisture content - Moisture measurement - Direct and indirect methods, Equilibrium moisture content (EMC) - Determination of EMC - EMC models - Hysteresis - Bound, unbound and free moisture, Drying curves - Constant rate period and falling rate period - Deep bed drying, Methods of grain drying - Conduction, Convection, Radiation, Dielectric, Chemical and Sack drying. Principles of operation of different types of dryers viz. Deep bed dryers, flat bed dryers, continuous flow dryers, L.S.U. dryers, fluidized bed dryers, rotary dryer, spouted beds, tray and tunnel dryers.

Paddy and its handling - Cleaning - Drying - Methods of paddy drying - Sun drying and mechanical drying

Storage of Cereals and Pulses: Introduction, need and importance, general principles of storage, temperature and moisture changes during storage i.e. influence of moisture content, relative humidity, temperature, fungi etc. on stored product. Fungi, insect and other organism associated with stored grains. Familiarization with the various types of storage structures. Deep and shallow bins. Traditional and modem storage structures. Management of storage structures. Losses during storage and their control, space requirement of bag storage structure.

Agricultural Structures: Livestock production facilities, BIS. Standards for dairy, piggery, poultry and other farm structures. Construction and cost estimation of farm structures; animal shelters, compost pit, fodder silo, fencing and implement sheds, barn for cows, buffalo, poultry, etc.

Practical

Determination of physical properties of agricultural materials e.g. size, shape, density and angle of repose. Study of operation and adjustments of air screen cleaner-cum-grader. Study of operation and adjustment of specific gravity separator. Study of operation and adjustment of indented cylinder separator. Determination of moisture content of grains. Study of different types of dryers. Study of domestic grain storage structures. Visit to warehouses (bag storage and bulk storage structures). Visit

to cold-storage. Study of different packaging materials.

Suggested Readings

1. Post-Harvest Technology of Cereal, Pulses, Oil seeds by A.Chakraverty; Oxford & IBH Publication Co.
2. Unit operation of Agro Processing Engineering by Dr. K.M. Sahay& K.K Singh; Vikas Publications.
3. Physical properties of plant and animal materials by N.N. Mohsenin, Gordon and Breach, 1970
4. Post-Harvest Technology of fruits & Vegetables by Thompson; CBS Publishers and Distributors, 485 Jain Bhavan, Shandara Delhi-II 0032.
5. Post-Harvest (Introduction Physiology Handling fruits & Vegetables by Wills R.B.H. etal; Oxford & IBH Publication Co.

AE4.3	Farm Power	3(2+1)

Theory

Principles of IC Engines:-Introduction and classification of IC engines. Working principle of four stroke and two stroke cycle. Petrol and Diesel engines, their comparison location and function of various parts of IC engines and material used for them. Concept of IC engine terms, bore, stroke, dead centre, crank throw, compression ratio, clearance volume, swept volume/piston displacement, total volume, engine displacement and piston speed. Calculation of IHP, BHP, FHP and engine efficiencies. Working principle of rotary engine.

Air Intake System:-Components of air intake system viz. pre-air cleaner, inlet manifold, exhaust manifold, types of air cleaners: wet, dry

Fuel System in Diesel Engine: Components of fuel system, description and working of fuel feed pump, types working of fuel injection pump, injector, fuel filters, complete detail and working of micro fuel injection system for a multi cylinder engine

Cooling and Lubrication: Necessity of engine cooling, cooling system, their main features, thermostat, defects in cooling system and their rectification, functions of lubrication, types and properties of engine lubricants, additives for improving the properties , lubrication system of IC engine, oil pumps, oil filters, pressure relief valve, positive crank case ventilation.

IC Engine Testing: Engine power, indicated and brake power, efficiency - mechanical, thermal, relative and volumetric efficiencies, methods of finding indicated and brake horse power, Morse test and heat balance sheet performance and endurance tests of IC engine specification (according To ISI). Exhaust smoke analysis and pollution control. Maintenance, repair and overhaul of engines

Practical

Identification of various types of diesel engines; Identification of various tools used for dismantling and assembling IC engines ;Performing pre-starting checks on engine; Engine dismantling and inspection of various parts, measurements of clearances; Engine assembly and trouble shooting, Study of engine governing system, Study of valve system, Study of fuel injection equipment of multi cylinder engine, dismantling and reassembling, Study of cooling system, water pump, thermostat valve; Study

of lubrication system, oil pump, oil filter. Determination of indicated power/brake power and specific fuel consumption.

Suggested Readings

1. Farm Tractors by S.C. Jain and Rai; Tata Oxford Company.
2. IC Engine by S.S. Thethi.
3. Elements of Agricultural Engineering by Dr. Jagdishwar Sahay; Standard Publisher Distributors, Nai Sarak, Delhi-ll0006.

AE4.4	Ground Water and Drainage Engineering	3(2+1)

Theory

Well Hydraulics: Ground water sources, types of water bearing formations (confined, unconfined aquifer etc.) aquifer characteristics influencing yield of wells. Determination of aquifer constant, specific capacity of wells. Different terms related to well hydraulic such as water tables, isobath, isobar lines, draw down. Recharge of ground water.

Open Wells and Tube Wells: Types of wells, open wells, their design parameters and construction of an open well, tube wells, methods of drilling tube wells-rotary drilling, core drilling and percussion drilling. Well installation and well development-objectives and methods. Testing of tube well.

Salt affected soils and their reclamation: Saline, alkaline and acid soils, Reasons and factors of their formation. Effect of salinity, alkalinity and acidity on plant growth. Reclamation of these soils and their management.

Waterlogged soils and their drainage: Water logging, causes of water logging and its effects. Drainage. Types of drainage systems viz. surface and subsurface drainage. Introduction to drainage investigation. Benefits of drainage. Drainage properties of soil. Drainage coefficient. Surface drainage-functional components, types (random drain, parallel field drain, parallel open ditch and bedding system used in flat areas and cross slope ditch system used in sloping areas). Introduction to design criteria and design parameters of open ditches. Benefits of subsurface drainage. Introduction to investigations for subsurface drainage, different method of subsurface drainage viz. tile drains, mole drains, deep open drains and combination of tile and opened drains.

Practical

To study the rainfall measurement system. To study the types of water bearing formations. Study of different types of wells. Different methods of ground water investigation. Study of different types of screen and strainers. Determination of hydraulic conductivity under laboratory and field conditions. Determination of drainable porosity. Determination of drainage requirement. To determine leaching requirement and gypsum requirement for reclamation of saline and sodic soils. Study of different types of filters and strainers used in subsurface drainage system.

Suggested Readings

1. Water well & Pump Engineering by A.M. Michael & S.D. Khepar; Tata McGraw Hill Publishing Co. Ltd., New Delhi.
2. Irrigation Theory and Practice by A.M. Michael; Vikas Publishing House, New Delhi.
3. Principles of Agricultural Engineering (Vol-II) by A.M. Michael & T.P. Ojha; Jain Brothers, New

Delhi.
4. Land and Water Management Engineering by V.V.N. Murthy.

AE4.5	Irrigation Technology	3(2+1)

Theory

Introduction: Irrigation, necessity of irrigation and advantages and disadvantages of irrigation. Types of irrigation viz. artificial (flow, lift etc.) and natural. Sources of irrigation water. Quality of irrigation water.

Water Requirement of Crops: Evaporation, measurement of evaporation by pan evaporimeter. Transpiration and transpiration ratio. Evapotranspiration or consumptive use, seasonal consumptive use, peak period consumptive use. Measurement of evapotranspiration by direct methods viz. Lysimeter experiment, Field experimental plots. Estimation of evapotranspiration from evaporation data and climatological data (introduction only). Water infiltration and determination of infiltration rate. Water requirement, net and gross irrigation requirement of crops. Irrigation frequency and irrigation period. Estimation of irrigation depth and irrigation scheduling, irrigation intensity Duty and Delta; factors affecting duty and methods of improving duty. Irrigation efficiencies- water conveyance, application, storage, distribution, and water use, and project, operational and economic efficiency. Uniformity coefficient.

Water Application Methods: Surface methods of irrigation viz. border, check basin and furrow irrigation, their basic details, characteristics, types and their adaptability. Concept of sub-surface irrigation method, its importance and adaptability. Sprinkler and Drip irrigation: their adaptability and limitations.

Water Lifting Devices: Introduction to various water lifting devices viz. manual, animal and power operated. Classification of pumps-positive displacement (reciprocating and rotary), variable displacement. Terms related to pumps. Principle of operation of centrifugal pumps (volute and diffuser type, single stage and multistage type). Types of impellers of centrifugal pump; Installation, operation and maintenance of centrifugal pumps, submersible pump and vertical turbine pumps; their common troubles and remedies. Principles of operation of propeller and jet pumps, their adaptability and limitations. Criteria and procedures for selection of irrigation pumps, power requirements, efficiency and economics of irrigation pumping plants.

Conveyance of irrigation water: Canals and their classification (brief description only), seepage from canals and field channels. Canal lining-various types. Their advantages and disadvantages. Introduction to various water conveyance structures and their functions e.g. flumes, tunnels, inverted siphons, flexible tubing and gated pipes. Open channels, their types, and layout and design parameters. Subsurface systems of water conveyance, their components, hydraulics and layout.

Practical

Installation and operation of centrifugal pump; Dismantling of centrifugal pump, study of constructional feature of its component and its assembly; Installation, operation & maintenance of submersible pump. Identifying/locating the faults/troubles and remedies; Determination of infiltration rate of soil. Problems on water requirement of crops, duty, delta, base period, irrigation scheduling, irrigation efficiency, etc.

To survey market and field for the availability, adaptability and selection of various types of pumps and irrigation systems in the region; Measurement of irrigation water in the field channels with the use of Parshall flumes, H, HS, HL and weir. Design problems on lined and unlined channels. Study tours to irrigation and drainage projects.

Suggested Readings

1. Irrigation Engineering by M. Lal& et al.; New India Publishing House.
2. Water use Efficiency in Agriculture by Giriappa; Oxford & IBH Publication Co.
3. Irrigation Practice & Water Management by FAO; Oxford & IBH Publication Co.
4. Irrigation Engineering by Sharma & Bari; Satya Parkashan Publishers.
5. Irrigation Engineering (Vol. 1, 2, 3) by Sharma & Sharma; Oxford & ffiH Publication Co.
6. Irrigation Water Power & Water Resource Engineering by K. R. Arora; Standard Publication.
7. Irrigation & Water Power Engineering by Dr. B.C. Punamia& et al; Laxmi Publication, New Delhi.
8. Sprinkler Irrigation by Sivanappan; Oxford & IBH Publication Co.
9. Water well & Pump Engineering by A.M. Michael & S.D. Khepar; Tata McGraw Hill Publishing Co. Ltd., New Delhi.
10. Irrigation Theory and Practice by A.M. Michael; Vikas Publishing House, New Delhi.
11. Principles of Agricultural Engineering (Vol-II) by A.M. Michael & T.P. Ojha; Jain Brothers, New Delhi.

AE4.6	Refrigeration and Air- Conditioning	2(1+1)

Theory

Definition of pure substance, phases of a pure substance, phase change process of a pure substances; T-V diagram for heating of water at constant pressure; Latent heat: latent heat of fusion, latent heat of vaporization; liquid vapour saturation curve; property diagram for phase change process, Principles of refrigeration, units, terminology, production of low temperatures, air refrigerators working on reverse Carnot cycle and Bell Coleman cycle; Vapour refrigeration-mechanism, P-V, T- S,P-h diagrams, vapour compression cycles, dry and wet compression, supercoiling and sub cooling; Vapour absorption refrigeration system; Common refrigerants and their properties; Thermodynamic properties of moist air, perfect gas relationship for approximate calculation, adiabatic saturation process, wet bulb temperature and its measurement, psychometric chart and its use, elementary psychometric processes Air conditioning: principles, type and functions of air conditioning, physiological principles in air conditioning, air distribution, factors considered for designing an air-conditioning system; Room ratio line, sensible heat factor, by-pass factor; types of air conditioners and their applications; Cold storage plants; calculation of refrigeration load and cold storage design considerations.

Practical

Study of P-V and T-S chart in refrigeration; Study P-h chart (or) Mollier diagram in refrigeration; Solving problems on air refrigeration cycle; Solving problems on vapour compression refrigeration cycle; Study of domestic water cooler; Study of domestic household refrigerator; Study of vapour absorption refrigeration system; Study of cooling tower and to find its efficiency ;Study of heat pump test rig; Study of Ice plant test rig; Study of psychometric chart and various psychometric processes; Solving problems on psychometrics; Study of window air conditioner; Study cold storage for fruit and

vegetables, freezing load and time calculations for food materials; Study on repair and maintenance of refrigeration and air-conditioning systems; Visit to chilling or ice making and cold storage plants.

Suggested Readings:

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

AE4.7	Renewable Energy Sources	3(2+1)

Theory

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

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

Wind energy- energy availability, general formula, lift and drag; Basics of wind energy conversion, effect of density, frequency variances, angle of attack, wind speed, types of windmill rotors; Working principle of wind power plant; Wind farms, aero-generators, wind power generation system.

Biogas- basics of anaerobic digestion, types and constructional details of biogas plants, biogas generation and its properties, factors affecting biogas generation and usages, design considerations, advantages and disadvantages of biogas spent slurry; Biomass Conversion: Pelleting and Densification (Briquetting).

Power generation from urban, municipal and industrial waste; Ocean thermal and electric power generation, wave and tidal power; Power generation from biomass (gasification & Dendro- thermal); Mini and micro hydel plants; Fuel cells and its associated parameters.

Practical

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

Suggested Reading

1. Rai G D. 1998. Non-conventional Sources of Energy. Khanna Pub.
2. Rathore N S, Kurchania A K and Panwar N L. 2006. Renewable Energy: Theory & Practice. Himanshu Publications.

3. Solanki C S. 2011. Solar Photovoltaic: Fundamentals, Technologies and Applications. PHI Learning Private Ltd.

AE4.8	Theory of Machines	2(2+0)

Theory

Simple mechanism: elements, links, pairs, kinematics chain, and mechanisms; classification of pairs and mechanisms; lower and higher pairs; four bar chain, slider crank chain and their inversions; Velocity mechanism: determination of velocity and acceleration using graphical (instantaneous centers) method; Types of gears, law of gearing, velocity of sliding between two teeth in mesh; Involute and cycloidal profile for gear teeth; Spur gear, nomenclature; Introduction to helical, spiral, bevel and worm gear; Simple, compound, reverted, and epicyclic trains; determining velocity ratio by tabular method; Turning moment diagrams, coefficient of fluctuation of speed and energy, weight of flywheel, flywheel applications; Belt drives: types of drives, belt materials, length of belt, transmitted power, velocity ratio, belt size for flat and V belts; effect of centrifugal tension, creep and slip on power transmission; chain drives, classification of chain drive, terms used in chain drive Types of friction, laws of dry friction; friction of pivots and collars; single disc, multiple disc, and cone clutches, rolling friction; Types of governors, constructional details and analysis of Watt, Porter, Proell governors, effect of friction, controlling force curves. Sensitiveness, stability, hunting, isochronism, power and effort of a governor; Static and dynamic balancing, balancing of rotating masses in one and different planes.

Suggested Readings

1. Theory of Machines by Bevan Thomas. 1984. CBS Publishers and Distributors, Delhi.
2. Theory of Machines by Ballaney P L. 1985. Khanna Publishers, 2-B Nath Market, NaiSarak, New Delhi.
3. Mechanisms and Machine Theory by Rao J S and Dukkipatti R V. 1990. Wiley and Sons Ltd., New Delhi.
4. Theory of Mechanisms and Machines by LalJagdish. 1991. Metropolitan Book Co. Pvt.Ltd., 1 NetajiSubash Marg, New Delhi..
5. Theory of Machines by Rattan S B. 1993. Tata McGraw Hill Publishing Co. Ltd., 12/4 Asaf Ali Road, New Delhi.
6. Theory of Machines by Khurmi R S and Gupta J K. 1994. Eurasia Publishing House Pvt. Ltd., Ram Nagar, New Delhi.

Semester-V

AE5.1	Computer Programming and Data Structures	2(0+2)

Practical

Introduction to high level languages; Structure programming, C programming, a simple C programming, execution of a C program, program and instruction; Familiarizing with Turbo C IDE; Building an executable version of C program; Study of different operators such as arithmetic, relational, logical, assignment, increment and decrement, conditional, bitwise and special operators,

precedence of arithmetic operators; Debugging a C program; Developing and executing simple programs; Creating programs using decision making statements such as if, go to and switch; Developing program using loop statements while, do and for; Using nested control structures; Familiarizing with one and two dimensional arrays; Using string functions; Creating user defined functions; Introduction to structures, union, pointers, linked list and queues.

Suggested Readings

1. Augenstein, L. and Tanenbaum. 2003. Data structures using C and C++. PHI/Pearson Education.
2. Balagurusamy, E. 1990. Programming in 'C'. Tata McGraw Hill Publishing Co. Ltd., 12/4 Asaf Ali Road, New Delhi.
3. Bronson, G. and Menconi, S. 1995. A First Book of 'C' Fundamentals of 'C' Programming. Jaico Publishing House, New Delhi.
4. Drozdek, A. 2012. Data Structures and Algorithms in C++. Vikas Publishing House / Thomson International Student Edition.
5. Goodrich, M T, Tamassia, R and Mount, D. 2011. Data structures and Algorithms in C++. Wiley Student Edition, John Wiley and Sons.
6. Rajaraman, V. 1985. Computer Oriented Numerical Methods. Prentice Hall of India. Pvt. Ltd, New Delhi.
7. Rajaraman, V. 1995. Computer Programming in 'C'. Prentice Hall of India Pvt. Ltd., New Delhi.
8. Sahni, S. 2006. Data Structures, Algorithms and Applications in C++. University Press (India) Pvt. Ltd / Orient Longman Pvt. Ltd.
9. Weiss, M. A. 2007. Data Structures and Algorithm Analysis in C++. Pearson Education.
10. Agarwal, A. 2005. The Complete Reference Guide: Data Structure through C. ISBN:8178840448; Publisher: Cyber Tech Publications.

AE5.2	Entrepreneurship Development and Business Communication	3(2+1)

Theory

Development of entrepreneurship, motivational factors, social factors, environmental factors, characteristics of entrepreneurs, entrepreneurial attributes/competencies. Concept, need for and importance of entrepreneurial development. Evolution of entrepreneurship, objectives of entrepreneurial activities, types of entrepreneurs, functions of entrepreneurs, importance of entrepreneurial development, and process of entrepreneurship development. Environment scanning and opportunity identification need for scanning–spotting of opportunity-scanning of environment–identification of product / service – starting a project; factors influencing sensing the opportunities. Infrastructure and support systems- good policies, schemes for entrepreneurship development; role of financial institutions, and other agencies in entrepreneurship development. Steps involved in functioning of an enterprise. Selection of the product / services, selection of form of ownership; registration, selection of site, capital sources, acquisition of manufacturing know how, packaging and distribution. Planning of an enterprise, project identification, selection, and formulation of project; project report preparation, Enterprise Management. Production management – product, levels of products, product mix, quality control, cost of production, production controls, Material management. Production management – raw material costing, inventory control. Personal management – manpower planning, labour turn over, wages / salaries. Financial management /accounting – funds, fixed capital

and working capital, costing and pricing, long term planning and short-term planning, book keeping, journal, ledger, subsidiary books, annual financial statement, taxation. Marketing management- market, types, marketing assistance, market strategies. Crisis management- raw material, production, leadership, market, finance, natural etc.

Practical

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

Suggested Readings

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

AE5.3	Micro Irrigation System Design	3(2+1)

Theory

Need of micro-irrigation systems. Role of Govt. for the promotion of micro-irrigation in India. Merits and demerits of micro-irrigation system. Types and components of micro-irrigation system. Micro-irrigation system- design, design synthesis, installation, and maintenance. Sprinkler irrigation- types, planning factors, uniformity and efficiency. Laying pipeline, hydraulic lateral, sub-mains and main line design, pump and power unit selection. Drip irrigation – potential, automation, crops suitability. Fertigation – Fertilizer application criteria, suitability of fertilizer compounds, fertilizer mixing, injection duration, rate and frequency, capacity of fertilizer tank. Use of AutoCAD and GPS survey in design and layout of MIS.

Practical

Study of different types of micro-irrigation systems and components. Field visit of micro-irrigation system. Study of water filtration unit; Discharge measurement study of different micro-irrigation systems. Study of water distribution and uniformity coefficient. Study of wetted front and moisture distribution under various sources of micro-irrigation system. Design of micro-irrigation system for an orchard. Design of micro-irrigation system for row crops design of spray type micro-irrigation system. Design of micro-irrigation system for hilly terraced land. Study of automation in micro-irrigation system. Study of micro climate inside a Polyhouse. Study of maintenance and cleaning of

different components of various systems. Design of sprinkler irrigation system. Design of landscape irrigation system

Suggested Readings

1. Principles of Sprinkler Irrigation by M S Mane, B L Ayare,
2. Principles of drip irrigation System by M S Mane, B L Ayare, S SMagar
3. Text Book of Irrigation Engineering and Drainage by R.K. Sharma and T.K. Sharma
4. Irrigation Engineering by R. Lal
5. Sprinkler Irrigation by R.K. Sivanappan
6. Irrigation Principles and Practices, by O.W. Israelsen, V.T. Hansen and Stringhem
7. Irrigation System: Design and Operationby D. Karmeli, G. Peri and M. Todes.

AE5.4	Post-Harvest Engineering	3(2+1)

Theory

Overview of Post-Harvest Technology. Post-harvest losses, reasons for losses, importance of loss reduction, Post-Harvest Handling operations. Cleaning; Cleaning of grains, washing of fruits and vegetables, types of cleaners, screens, types of screens, rotary screens, vibrating screens, machinery for cleaning of fruits and vegetables (air cleaners, washers), cleaning efficiency, care and maintenance; Peeling. Sorting, grading, methods of grading; Grading- Size grading, colour grading, specific gravity grading; screening, equipment for grading of fruits and vegetables, grading efficiency, care and maintenance Magnetic separator, destoners, electrostatic separators, pneumatic separator. Decorticating and Shelling; Principles of working of various decorticators/dehullers/shellers, description of groundnut decorticators, maize shellers, etc. Milling, polishing, grinding, milling equipment, de-huskers, polishers (abrasion, friction, water jet), flour milling machines, pulse milling machines, grinders, cutting machines, oil expellers, machine efficiency and power requirement. Materials handling; Introduction to different conveying equipment used for handling of grains; Scope and importance of material handling devices. Study of different Material Handling systems; Classification, principles of operation, conveyor system selection; Belt conveyor; Chain conveyor; Screw conveyor; Bucket elevator; Pneumatic conveying system; Gravity conveyor.

Practical

Study of cleaners for grains; Study of washers for fruits and vegetables; Study of graders for grains; Study of graders for fruits and vegetables; Study of decorticators; Study of a maize/ sunflower sheller; Study of crop dryers; Study of a RF/MW/tray dryer; Study of hot air dryer and modelling drying kinetics; Study of vacuum dryer and modelling drying kinetics; Study of working principle of spray dryer and spray drying process; Study of drum dryer and liquid food dehydration using drum drying; Study of fluidized bed dryer and drying process; Study of freeze dryer and freeze drying process; Study of rice milling machines; Study of pulse milling machines; Study of different components of flour mill; Study of different materials handling equipment.

Suggested Readings

1. Boumans, G. 1985. Grain Handling and Storage. Elsevier Science Publishers, Amsterdam, The Netherlands.
2. Brennan, J.G. 2006. Food Processing Handbook. Wiley-VCH Verlag GmbH and Co. KGaA, Weinheim, Germany.

3. Chakraverty, A. 2008. Post Harvest Technology of Cereals, Pulses and Oilseeds, 3rd edn. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
4. Chakraverty, A. and Singh, R.P. 2014. Post Harvest Technology and Food Process Engineering. CRC Press, Boca Raton, FL, USA.
5. Dash, S K, Bebartta, J P and Kar, A. 2012. Rice Processing and Allied Activities. Kalyani Publishers.
6. Earle, R.L. 1983. Unit operations in Food Processing. Pergamon Press, New York, USA.
7. Green, D.W. and Perry, R.H. 2008. Perry's Chemical Engineers' Handbook. McGraw-Hill Co., Inc., NY, USA.
8. Hall, C. W. and Davis, D. C. 1979. Processing Equipment for Agricultural Products. The AVI Publishing Company, Inc., Connecticut, MA, USA.
9. Henderson, S.M. and Perry, R.L. 1966. Agricultural Process Engineering, 2nd Ed. The AVI Publishing Company, Inc., Connecticut, MA, USA.
10. Mohsenin, N.N. 1980. Thermal Properties of Foods and Agricultural Materials. Gordon and Breach Science Publishers, New York.
11. Mohsenin, N.N. 1984. Electromagnetic Radiation Properties of Foods and Agricultural Products. Gordon and Breach Science Publishers, New York.
12. Mohsenin, N.N. 1986. Physical Properties of Plant and Animal Materials: Structure, Physical Characteristics and Mechanical properties, 2nd edn. Gordon and Breach Science Publishers, NY.
13. Pandey, H. Sharma, H.K., Chauhan, R.C., Sarkar, B.C. and Bera, M.B. 2010. Experiments in food process engineering. New Delhi: CBS Publisher and Distributors Pvt Ltd.
14. Sahay, K.M. and Singh, K.K. 2001. Unit Operations of Agricultural Processing. Vikas Publishing House Pvt. Ltd., Noida, UP.

AE5.5	Tractor Systems and Controls	3(2+1)

Theory

Introduction: Sources of farm power and scope of mechanization. Tractor - classification and different type of tractors and systems. Main assemblies of the tractors.

Power Transmission System of Tractors: Functions and various components of power train. Clutch; functions of clutch, type of clutch (single plate, dual plate and multi plate clutch). Gear box; function and working of gear box, types of gear boxes (sliding, constant mesh and synchromesh gears). Differential and differential lock; function and constructional details. Final drive; reduction gear and rear axle. Power take off shaft and drive to the PTO shaft.

Braking System: Importance and function of brakes, various types of brakes viz. mechanical and hydraulic and their working.

Wheels and Tyres: Types of wheels rim and tyres used in tractors. Function of tyres. Causes of tyre wear. Need for changing the rear wheel, spacing of wheels and arrangement for the change. Wheel ballasting and methods of ballasting.

Hydraulic System; Principles and working of hydraulic system.

Steering System; Functions and components of steering systems.

Electrical System: components of electrical systems viz. battery, starter switch, self-starter, motor, and dynamo: their construction, functions, operation; maintenance and care of the battery.

Economics: Selection and Safety of Tractors. Various factors affecting the right selection of a tractor. Safety measures in the operation of tractor, cost analysis of use of tractors.
Periodical Maintenance, Repair and Overhauling of Tractor. Daily, weekly and monthly maintenance, repair and overhauling of tractor.
Tractor Testing: Traction, Terms related to traction- Traction efficiency, coefficient of traction, rolling resistance, slip, rim pull. Tractor testing stations, test conditions, general requirements for testing a tractor. Type of tests.

Practical
Familiarization with tractors available in India; Familiarization with various tools used for dismantling and assembling of tractors and implements; Study of clutch and its components and assembly; Study of gear box, differential and final drive; Study of Brake and steering Wheel equipment-care and maintenance, fitting of wheels and adjustment of track width; Operation of hydraulics system, draft position and mix control systems; Periodical maintenance and service of tractors; Repair and overhaul of tractors; To prepare the cost estimate for repair work.

Suggested Readings
1. Elements of Agricultural Engineering by Dr. JagdishwarSahay; Standard Publisher Distributors, NaiSarak, Delhi-ll0006.
2. Farm Power Machinery & Surveying by Irshad Ali; KitabMahal, Allahabad, Surjit Book Depot
3. P.B. No. 1425,4074-75, NaiSarak, Delhi.
4. Principle of Agricultural Engineering Volume-I by A.M. Michael &T.P.Ojha; Jain brothers.
5. Farm Machines &Equipments by C.P. Nakra; DhanpatRai&Sons ,NaiSarak New Delhi.
6. Farm Tractors Maintenance & repairs by S.C. Jain & C.R. Rai; Tata McGraw-hill Publishing Co. Ltd., New Delhi.
7. Elements of Agricultural Engineering Part 1 & 2 by Dr. O.P. Singhal and Naresh Chandra Aggarwal; Mumfordganj, Allahabad.
8. Basic Farm Machinery by Shiphen& Ellen; Jain brothers.
9. Tractors and Their Power Units by John B. Liljedahl&*et al.* Wiley India Pvt. Ltd, New Delhi.

Semester-VI

AE6.1	Industrial Training and Experience	20(0+20)

To provide students with an opportunity to put into practice the skills they have learned while studying in the institute. In addition, students will have an opportunity to enhance those skills, obtain the perspective of a work environment and benefit from a mentor or supervisor's experience and advice. The students will have internship/ training for 16 weeks' duration in industries/ research organisations/ institutions. The College will facilitate attaching the students to the organisations. In-plant training may be conducted in split manner in more than one industry/ organization/ institute. After completion of training/ internship, the students will have to submit a report of their learnings and also present in form of a seminar before nominated faculty members and other students. The assessment will be based on the report / assessment received from the industry/ organisation and the

report and the presentation made at the College. Ideally the weightage will be 50% each for both internal and external. The institute may modify the weightage and breakups.

The evaluation criteria for report can be as follows:

Sr. No.	Performance criteria	Max. marks	Rating Scale				
			Excellent	Very Good	Good	Fair	Poor
1.	Selection of assignment	10	10	8	6	4	2
2.	Planning and execution of considerations	10	10	8	6	4	2
3.	Quality of performance	20	20	16	12	8	4
4.	Providing solution of the problems or production of final product	20	20	16	12	8	4
5.	Sense of responsibility	10	10	8	6	4	2
6.	Self-expression, communication skills	5	5	4	3	2	1
7.	Interpersonal skills/human relations	5	5	4	3	2	1
8.	Report writing skills	10	10	8	6	4	2
9.	Viva voce	10	10	8	6	4	2
Total marks		100	100	80	60	40	20

A suggestive criteria for assessing student performance by the external (personnel from industry) and internal (teacher) examiner is given in table below:

1.	Range of maximum marks	Overall Grade
2.	More than 75	Excellent
3.	66-75	Very good
4.	61- 65	Good
5.	45- 60	Pass
6.	Less than 45	Fail

In order to qualify for the diploma, students must get "Overall grade- Pass" failing which the students may be given one more chance of undergoing 8 -10 weeks of project oriented professional training in the same industry and re-evaluated before being disqualified and declared "not eligible to receive diploma ".

Electives

AE5.6	Development of Processed Food Products	3(2+1)

Theory:

Process of new product development; Process flow chart with mass and energy balance; Unit operations and equipment for processing; Technologies for value addition of cereals, pulses and oil seeds- milled, puffed, flaked, roasted and malted products, bakery products, snack food, extruded products; Technologies for value added products from fruits, vegetables and spices as canned foods, frozen foods, dried foods, fried foods, fruit juices, sauce, sugar based confectionery, candy, fermented products, spice extract; Technologies for value addition of liquid foods such as milk, sugarcane juice, etc.; Technologies for value addition of forest produce as mahua and tamarind;

Technology for processing of animal produce, viz. meat, poultry, fish, egg products; Technologies for preparation of health foods, nutraceuticals and functional food; Organic food processing.

Practical:
Process design and preparation of process flow chart; Preparation of different value added products; Visit to roller flour mill, rice mill, spice grinding mill, milk plant, dal and oil mill, fruit/ vegetable processing plant, sugar mill and other food processing industries & study of operations and machinery.

Suggested Readings

1. Acharya, K. T. 2017. Everyday Indian Processed Foods. National Book Trust.
2. Dash, S. K., Chandra, P. and Kar, A. 2024. Food Engineering Principles and Practice. CRC Press, Boca Raton, USA
3. Mudambi, S. R., Rao, S. M. and Rajgopal, M. V. 2006. Food Science. New Age International Publishers.
4. Negi, H. P. S., Sharma, S. and Sekhon, K. S. 2007. Handbook of Cereal Technology. Kalyani Pub.
5. Potter, N. N. and Hotchkiss, J. H. 1995. Food Science. Chapman and Hall Pub.
6. Rao, D. G. 2009. Fundamentals of Food Engineering. PHI Learning Pvt. Ltd, New Delhi.
7. Srivastava, R. P. and Kumar, S. 2019. Fruit and Vegetable Preservation: Principles and Practices. International Book Distributing Company.

AE5.7	Engineering Graphics and Design	3(2+1)

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

Suggested Reading

1. Lee, K. 1999. Principles of CAD/CAM/CAE Systems. Addison Wesley Longman, Inc.
2. Rao, P. N. 2002. CAD/CAM Principles and Applications. McGraw-Hill Education Pvt. Ltd., New Delhi.
3. Sareen, K. and Grewal, C. D. 2010. CAD/CAM Theory and Practice. S. Chand & Company Ltd., New Delhi.
4. Zeid, I. 2011. Mastering CAD/CAM with Engineering. McGraw-Hill Education Pvt. Ltd., New Delhi.

AE5.8	Food Packaging Technology	3(2+1)

Theory:

The shelf life of food materials during storage is influenced by various factors, including the interactions of spoilage agents with environmental conditions such as water activity, oxygen levels, light exposure, and pH. Controlling these factors is essential to mitigate spoilage, which can be managed by understanding the general principles of controlling spoilage agents. Additionally, there is a distinction between food infection (caused by the ingestion of pathogens), food intoxication (caused by toxins produced by microorganisms), and food allergies (immune responses to certain food proteins). Packaging plays a critical role in food preservation, offering protection from spoilage agents while extending shelf life. The requirements and importance of food packaging encompass considerations for environmental impact, material selection, and application. Packaging systems can be classified as flexible or rigid, retail or bulk, and categorized into various levels. Packaging materials include metal cans (e.g., two-piece and three-piece cans), plastics (polymers and laminates with specific barrier properties), glass containers (manufactured with specific types of glass and closures), and paper and paperboard (processed for enhanced barrier properties). Each material has unique advantages and disadvantages, influencing its suitability for different commodities. Advancements in packaging include technologies like Controlled Atmosphere Storage (CAS), Modified Atmosphere Packaging (MAP), shrink and cling wraps, vacuum packaging, and gas packaging. Emerging trends such as active and smart packaging aim to improve functionality and food safety. Nutritional labeling is another critical aspect of packaging, providing consumers with essential product information. Packaging requirements vary between raw and processed foods, necessitating careful selection of materials to ensure product safety and quality. Environmental considerations include the disposal and recycling of packaging waste, with growing emphasis on sustainability. Package testing ensures the reliability of packaging materials, involving various tests for flexible materials (e.g., thickness, tensile strength, haze), rigid materials (e.g., visual defects, impact strength), semi-rigid materials, and specific tests for paper (e.g., bursting strength, folding endurance), plastics (e.g., polymer identification), aluminum foils (e.g., pinholes), glass containers (e.g., color and dimensions), and metal containers (e.g., pressure tests). These assessments ensure that packaging materials meet the required standards for protecting and preserving food products effectively.

Practical:

Identification of various types of packaging materials and the determination of their tensile and compressive strength to assess mechanical durability. Tests include both destructive and non-destructive methods for evaluating the structural integrity and quality of glass containers. The process also includes vacuum packaging of agricultural produce to study its effectiveness in preservation. Additionally, the tearing strength of paperboard and the thickness of packaging materials are measured to ensure quality standards. Grease-resistance tests are performed on plastic pouches, while the bursting strength of packaging materials is evaluated to determine their capacity to withstand pressure. The water-vapor transmission rate is measured to analyze the moisture barrier properties of packaging materials. Shrink wrapping is applied to various horticultural produce to examine its effectiveness. Further tests include assessing the chemical resistance of packaging materials and performing drop tests on food packages to evaluate their durability during handling. The activities are

complemented by visits to relevant industries for practical exposure to packaging technologies and practices.

Suggested Readings:

1. Coles, R., McDowell, D. and Kirwan, M. J. 2003. Food Packaging Technology. Blackwell Publishing Co.
2. Gosby, N. T. 2001. Food Packaging Materials. Applied Science Publication
3. John, P. J. 2008. A Handbook on Food Packaging. Narendra Publishing House.
4. Mahadevia, M. and Gowramma, R. V. 2007. Food Packaging Materials. Tata McGraw Hill.
5. Robertson, G. L. 2001. Food Packaging and Shelf life: A Practical Guide. Narendra Publishing House.
6. Robertson, G. L. 2005. Food Packaging: Principles and Practice. Second Edition. Taylor and Francis.

AE5.9	Minor Irrigation and Command area Development	3(2+1)

Theory

Major, medium and minor irrigation projects, factors affecting performance of irrigation projects; Types of minor irrigation systems in India, surface water and groundwater projects; Lift irrigation systems: feasibility, type of pumping stations and their site selection, design of lift irrigation systems; Tank irrigation: grouping of tanks, storage capacity, supply works and sluices; Earthen dams: components, types, methods of construction, causes of failure of earthen dams, seepage control in earthen dams;

Command area development (CAD) programme- components, need, scope, and development approaches, historical perspective, command area development authorities- objectives, functions and responsibilities; On farm development works, design of lined and un-lined field channel and its cost estimation; Farmers' participation in command area development, PIM, water user's association; Reclamation works, cross drainage works; Use of remote sensing techniques for CAD works; Rotational irrigation system, Warabandi, pre-requisites for warabandi; Conjunctive use of water, optimum utilization of water; Water productivity: concepts and measures for enhancing water productivity.

Practical

Preparation of command area development layout plan; Irrigation water requirement of crops of command area; Preparation of irrigation schedules; Planning and layout of water conveyance system; Design of surplus weir of tanks; Determination of storage capacity of tanks; Design of intake pipe and pump house; Planning and design of OFD works; Cost estimation of OFD work; Study of cross-drainage works; Design and cost estimation of earthen dams for minor irrigation project; Estimation of seepage in field channels; Visit to a minor irrigation project; Visit to a command area and study of OFD works; Study of reclamation of waterlogged areas inside command area.

Suggested Reading

1. Arora K R. 2001. Irrigation, Water Power and Water Resources Engineering. Standard Publishers Distributors, Delhi.

2. Garg S K. 2014. Irrigation Engineering and Hydraulic Structures. Khanna Publishers, New Delhi.
3. Michael A M. 2012. Irrigation: Theory and Practice. Vikas Publishing House New Delhi.
4. Sahasrabudhe S R. 2011. Irrigation Engineering and Hydraulic structures. SK Kataria & Sons, Reprint 2015.
5. Reddi G H S and Reddy T Y. 2005. Efficient use of Irrigation Water. Kalyani Publishers, Ludhiana.

AE5.10	Photovoltaic Technology and Systems	3(2+1)

Theory

Solar PV Technology: advantages, limitations, current status of PV technology, SWOT analysis of PV technology; Types of solar cells: Wafer based silicon cell, Thin film amorphous silicon cell, Thin Cadmium Telluride (CdTe) Cell, Copper Indium Gallium Selenide (CiGS) Cell, Thin film crystalline silicon solar cell; Solar photo voltaic module: solar cell, solar module, solar array, series & parallel connections of cell, mismatch in cell, fill factor, effect of solar radiation and temperature on power output of module, I-V and power curve of module, balance of solar PV system; Solar PV system designing and cost estimation;

Introduction to batteries, battery classification, lead acid battery, Nicked Cadmium battery, comparison of batteries, battery parameters; Charge controller: types and function of charge controller, PWM (Pulse width modulation) type, MPPT (Maximum Power Point Tracking) type charge controller; Converters: DC to DC converter and DC to AC type converter;

Application of solar PV system, solar home lighting system, solar lantern, solar fencing, solar street light, solar water pumping system, roof top solar photovoltaic power plant and smart grid

Practical

Study of V-I characteristics of solar PV system; Smart grid technology and application; Manufacturing technique of solar array; Different DC to DC and DC to AC converter; Domestic solar lighting system; Various solar module technologies; Safe measurement of PV modules electrical characteristics and commissioning of complete solar PV system.

Suggested Reading

1. Rai G D. 1998. Non-conventional Sources of Energy. Khanna Pub.
2. Rathore N S, Kurchania A K and Panwar N L. 2006. Renewable Energy: Theory & Practice. Himanshu Publications.
3. Solanki C S. 2011. Solar Photovoltaic: Fundamentals, Technologies and Applications. PHI Learning Private Ltd.
4. Meinel A B and Meinel M P. 1976. Applied Solar Energy: An Introduction. Addison-Wesley Educational Publishers Inc.
5. Derrick A, Francis C and Bokalders V. 1991. Solar Photo-voltaic Products. Intermediate Technology Publications.

AE5.11	Precision Agriculture and System Management	3(2+1)

Theory

Precision agriculture- need and functional requirements; Familiarization with issues relating to natural resources; Equipment for precision agriculture including sowing and planting machines, power sprayers, land clearing machines, laser guided land levelers, straw-chopper, straw-balers, grain combines, etc.; Introduction to GIS based precision agriculture and its applications; Introduction to sensors and application of sensors for data generation; Database management; System concept, system approach in farm machinery management, problems on machinery selection, maintenance and scheduling of operations; Application of PERT and CPM in machinery system management.

Practical

Familiarization with precision agriculture problems and issues; Familiarization with various machines for resource conservation; Solving problems related to various capacities, pattern efficiency, system limitation, etc.; Problems related to cost analysis, inflation and problems related to selection of equipment, replacement, break-even analysis, time value of money, etc.

Suggested Reading

1. DeMers M N. 2008. Fundamentals of Geographic Information Systems. Wiley.
2. Dutta, S. K. 1987. Soil Conservation and Land Management. International Book Distributors. Dehradun.
3. Hunt, D. 1956. Farm Power and Machinery Management. Iowa State College Press.
4. Kuhar, J. E. 1977. The Precision Farming Guide for Agriculturist. Lori J. Dhabalt, USA.
5. Sharma, D. N., Jain, M. and Lohan, S. K. 2021. Farm Power and Machinery Management. Jain Brothers.
6. Sigma and Jagmohan. 1976. Earth Moving Machinery. Oxford & IBH
7. Wood, S. 1977. Heavy Construction: Equipment and Methods. Prentice Hall.

AE5.12	Precision Farming Techniques for Protected Cultivation	3(2+1)

Theory

Protected cultivation: introduction, history, origin, development; national and international scenario; Types of green houses, components of green house, cladding materials, plant environment interactions, principles of limiting factors, solar radiation and transpiration, greenhouse effect, light, temperature, relative humidity, carbon dioxide enrichment; Design and construction of greenhouses-site selection, orientation, design, construction, design for ventilation requirement using exhaust fan system, selection of equipment; Greenhouse cooling system- methods, ventilation with roof and side ventilators, evaporative cooling, different shading materials, fogging, combined fogging and fan-pad cooling system, design of cooling system, maintenance of cooling and ventilation systems, pad care, etc.; Greenhouse heating- components, methods, design of heating system; Root media- types, soil and soilless media, composition, estimation, preparation and disinfection, bed preparation;

Planting techniques in green house cultivation; Irrigation in greenhouse and net house- water quality, types of irrigation system, components, design, installation and material requirement; Fogging system for greenhouses and net houses- introduction, benefits, design, installation and material requirement; Maintenance of irrigation and fogging systems

Fertilization- nutrient deficiency symptoms and functions of essential nutrient elements, principles of selection of proper application of fertilizers, fertilizer scheduling, rate of application of fertilizers, methods, automated fertilizer application;
Greenhouse climate measurement, control and management; Insect and disease management in greenhouse and net houses; Selection of crops for greenhouse cultivation, major crops in greenhouse- irrigation requirement, fertilizer management, cultivation, harvesting and post-harvest techniques; Economic analysis

Practical
Estimation of material requirement for construction of greenhouse; Determination of fertilization schedule and rate of application for various crops; Estimation of material requirement for preparation of root media; Root media preparation, bed preparation and disinfections; Study of different planting techniques; Design and installation of irrigation system; Design and installation of fogging system; Study of different greenhouse environment control instruments; Study of operation, maintenance and fault detection in irrigation system; Study of operation, maintenance and fault detection in fogging system; Economic analysis of greenhouses and net houses; Visit to greenhouses.

Suggested Reading

1. Singh B and Singh B. 2014. Advances in protected cultivation. New India Publishing Company.
2. Sharma P. 2007. Precision Farming. Daya Publishing House New Delhi.

AE5.13	Remote Sensing and GIS Applications	3(2+1)

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 measurement by the parallax method; Ground control for aerial photography; satellite remote sensing, multispectral scanner whiskbroom and push-broom scanner; Different types of resolutions; analysis of digital data- image restoration; image enhancement; Information extraction, image classification, unsupervised classification, supervised classification, important consideration in the identification of training areas, vegetation indices; Microwave remote sensing, GIS and basic components, different sources of spatial data, basic spatial entities, major components of spatial data; Basic classes of map projections and their properties; Methods of data input into GIS, data editing, spatial data models and structures, attribute data management, integrating data (map overlay) in GIS; Application of remote sensing and GIS for the management of land and water resources.

Practical

Familiarization with remote sensing and GIS hardware; Use of software for image interpretation; Interpretation of aerial photographs and satellite imagery; Basic GIS operations such as image display; Study of various features of GIS software package; Scanning, digitization of maps and data editing; Data base query and map algebra; GIS supported case studies in water resources management.

Suggested Reading

1. Reddy A M. 2006. Textbook of Remote Sensing and Geographical Information Systems. BS Publications, Hyderabad.
2. Elangovan K. 2006. GIS Fundamentals Applications and Implementations. New India Publication Agency, New Delhi.
3. George J. 2005. Fundamentals of Remote Sensing. 2nd Edition. Universities Press (India) Private Limited, Hyderabad.
4. Jensen J R. 2013. Remote Sensing of the Environment: An Earth Resource Perspective. Pearson Education Limited, UK.
5. Lillesand T, Kiefer R W and Chipman J. 2015. Remote Sensing and Image Interpretation. 7th Edition, John Wiley and Sons Singapore Pvt. Ltd., Singapore.
6. Sabins F F. 2007. Remote Sensing: Principles and Interpretation. Third Edition, Waveland Press Inc., Illinois, USA.
7. Sahu K C. 2008. Text Book of Remote Sensing and Geographic Information Systems. Atlantic Publishers and Distributors (P) Ltd., New Delhi.
8. Shultz G A and Engman E T. 2000. Remote Sensing in Hydrology and Water Management. Springer, New York.

AE5.14	Renewable Energy Technology	3(2+1)

Theory

Design and operational parameters of non-conventional devices, performance evaluation and maintenance aspects of gasifiers, performance evaluation and maintenance aspects of biogas plants, Performance evaluation and maintenance aspects of solar passive heating devices, Performance evaluation and maintenance aspects of photovoltaic cells and arrays, Performance evaluation and maintenance aspects of briquetting machines and balers, Utilization of bio-fuels in CI engines.

Practical

Performance evaluation of solar water heater, Performance evaluation of solar cooker, Characteristics of solar photovoltaic panel, Evaluation of solar air heater, Performance evaluation of a fixed dome type biogas plant, Performance evaluation of floating drum type biogas plant, Estimation of calorific value of producer gas, Testing of diesel engine operation using biodiesel, Performance evaluation of different biomass briquette.

Suggested Reading

1. Basu P. 2018. Biomass Gasification, Pyrolysis and Torrefaction. Academic Press.
2. Butler S. 2005. Renewable Energy Academy: Training wood energy professionals.
3. Knothe G, Gerpen J V, Krahl J. (Eds.). 2010. The Biodiesel Handbook. AOCS Press.

4. Rai G D. 2013. Non-Conventional Energy Sources. Khanna Publishers, New Delhi.
5. Reed T B and Das A. 1988. Hand book of Biomass Downdraft Gasifier Engine Systems. SERI.

AE5.15	Waste and By-products Utilization	3(2+1)

Theory

Types and formation of by-products and waste; Magnitude of waste generation in different food processing industries; Uses of different agricultural by-products from rice mill, sugarcane industry, oil mill etc.;

Concept, scope and maintenance of waste management and effluent treatment; Waste parameters and their importance in waste management- temperature, pH, Oxygen demands (BOD, COD), fat, oil and grease content, metal content, forms of phosphorous and sulphur in waste waters, microbiology of waste, other ingredients like insecticide, pesticides and fungicides residues.

Waste utilization in various industries, furnaces and boilers run on agricultural wastes and by products, briquetting of biomass as fuel, production of charcoal briquette, generation of electricity using surplus biomass, producer gas generation and utilization; Waste treatment and disposal: Design, construction, operation and management of institutional community and family size biogas plants, vermi- composting;

Pre-treatment of waste: sedimentation, coagulation, flocculation and floatation; Secondary treatments: biological and chemical oxygen demand for different food plant waste– trickling filters, oxidation ditches, activated sludge process, rotating biological contractors, lagoons; Tertiary treatments: advanced waste water treatment process- sand, coal and activated carbon filters, phosphorous, sulphur, nitrogen and heavy metals removal; Assessment, treatment and disposal of solid waste; Effluent treatment plants; Environmental performance of food industry to comply with ISO-14001 standards.

Practical

Determination of temperature, pH, turbidity solids content, BOD and COD of waste water; Determination of ash content of agricultural wastes and determination of un-burnt carbon in ash; Study about briquetting of agricultural residues; Estimation of excess air for better combustion of briquettes; Study of extraction of oil from rice bran; Study on bioconversion of agricultural wastes; Recovery of germ and germ oil from by-products of cereals; Visit to various industries using waste and food by- products.

Suggested Reading

1. Markel I A. 1981. Managing Livestock Waste. AVI Publishing Co.
2. Pantastico E C B. 1975. Post-harvest Physiology, Handling and Utilization of Tropical and Sub-tropical Fruits and Vegetables. AVI Pub. Co.
3. Shewfelt R L and Prussi S E. 1992. Post-Harvest Handling - A Systems approach. Academic Press Inc.
4. USDA 1992. Agricultural Waste Management Field Hand book. USDA, Washington DC.
5. Weichmann J. 1987. Post-Harvest Physiology of Vegetables. Marcel and Dekker Verlag.
6. Joshi V K and Sharma S K. 2011. Food Processing Waste Management: Treatment & Utilization Technology. New India Publishing Agency.

7. Vasso O and Winfried R (Eds.). 2007. Utilization of By-products and Treatment of Waste in the Food Industry. Springer Science & Business Media, LLC 233 New York.
8. Prashar A and Bansal P. 2008. Industrial Safety and Environment. S.K. Kataria and Sons, New Delhi.
9. Garg S K. 1998. Environmental Engineering (Vol. II) – Sewage Disposal and Air Pollution Engineering. Khanna Publishers, New Delhi
10. Bhatia S C. 2001. Environmental Pollution and Control in Chemical Process Industries. Khanna Publishers, New Delhi.

AE5.16	Watershed Management	3(2+1)

Theory

Watershed management - problems and prospects. Watershed based land use planning. Watershed characteristics – physical and geomorphologic, factors affecting watershed management. Hydrologic data for watershed planning. Watershed delineation, delineation of priority watershed. Water yield assessment and measurement from a watershed. Temporary structures for the control of gully erosion, their types and adaptability. Permanent soil conservation structures viz. Drop spillway, Chute spillway, Hydrologic and hydraulic design of earthen embankments and diversion structures. Drop inlet spillway for the control of erosion; their principles, adaptability, constructional features and material of construction. Introduction to the farm ponds, earthen embankments and water harvesting in relation to soil and water conservation, soil conservation through tree and grass cultivation. Concept of ground water recharge, watershed management. Sediment yield estimation and measurement from a watershed and sediment yield models. Rainwater conservation technologies in-situ and ex-situ, storage, design of water harvesting tanks and ponds. Water budgeting in a watershed. Effect of cropping system, land management and cultural practices on watershed hydrology. Evaluation and monitoring of watershed programmes. People's participation in watershed management programmes. Planning and formulation of project proposal; cost benefits analysis of watershed programmes. Introduction and application of remote sensing and GIS in watershed management

Practical

Study of watershed characteristic; analysis of hydrologic data for watershed management; Delineation of watershed and measurement of area under different vegetative and topographic conditions; Measurement of water and sediment yield from watershed; Study of different watershed management structures; Study of various water budget parameters; Study of watershed management technologies; Preparation of a techno-economically effective project proposal. Visit to watershed development projects.

Suggested Reading

1. Das G. 2008. Hydrology and Soil Conservation Engineering: Including Watershed Management. 2nd Edition, Prentice-Hall of India Learning Pvt. Ltd., New Delhi.
2. Katyal J C, Singh R P, Sharma S, Das S K, Padmanabhan M V and Mishra P K. 1995. Field Manual on Watershed Management. CRIDA, Hyderabad.
3. Mahnot S C. 2014. Soil and Water Conservation and Watershed Management. International Books and Periodicals Supply Service. New Delhi.

4. Rajora, R. 2019.Integrated Watershed Management. Rawat Publications, New Delhi.
5. Sharda V N, Sikka A K and Juyal G P. 2006. Participatory Integrated Watershed Management:
6. A Field Manual. Central Soil and Water Conservation Research and Training Institute, Dehradun.
7. Singh G D and Poonia T C. 2003. Fundamentals of Watershed Management Technology. Yash Publishing House, Bikaner.
8. Thomas C G. 2010. Land Husbandry and Watershed Management. Kalyani Publishers, Ludhiana.

AE5.17	Unit Operations in Food Processing	3(2+1)

Theory

Evaporation: Principles of evaporation, mass and energy balance, factors affecting rate of evaporation, thermodynamics of evaporation (phase change, boiling point elevation, Dühring plot; Heat and mass transfer in evaporator, factors influencing the overall heat transfer coefficient, influence of feed liquor properties on evaporation.

Evaporation equipment: Natural circulation evaporators, horizontal/vertical short tube, natural circulation with external calandria, long tube, forced circulation; Evaporator ancillary plant, design of evaporation systems, single effect, multiple effect evaporators, feeding methods of multiple effect evaporation systems, feed preheating, vapour recompression systems; Fouling of evaporators and heat exchangers; Recompression heat and mass recovery and vacuum creating devices.

Food freezing: Introduction, freezing point curve for food and water, freezing points of common food materials, Principles of food freezing, Freezing time calculation by using Plank's equation; Freezing systems; Direct contact systems, air blast immersion; Changes in foods; Frozen food properties; freezing time, factors influencing freezing time, freezing/thawing time; Freeze concentration: Principles, process, methods; Frozen food storage: Quality changes in foods during frozen storage; Freeze drying: Heat mass transfer during freeze drying, equipment and practice.

Expression and Extraction: liquid-liquid extraction processes, types of equipment and design for liquid-liquid extraction, continuous multistage counter current extraction; Leaching: process, preparation of solids, rate of leaching, types of equipment, equilibrium relations.

Crystallization and dissolution: Theory and principles, kinetics, applications in food industry, equipment for crystallization.

Distillation: Principles, vapour-liquid equilibrium, continuous flow distillation, batch/ differential distillation, fractional distillation, steam distillation, distillation of wines and spirits.

Baking: Principles, baked foods, baking equipment; roasting: Principles of roasting, roasting equipment.

Frying: theory and principles, shallow or contact frying and deep fat frying, heat and mass transfer in frying, frying equipment; Puffing: Puffing methods, puffing equipment.

Blanching: Principles and equipment; Pasteurization: Purpose, microorganisms and their reaction to temperature and other influences, Methods of heating, design and mode of operation of heating equipment, vat, tubular heat exchanger, plate heat exchanger.

Sterilization: Principles, process time, T-evaluation, design of batch and continuous sterilization, different methods and equipment; UHT sterilization, in the package sterilization, temperature and pressure patterns, equipment for sterilizing goods in the package.

Aseptic processing: principles, analysis of thermal resilience, duration mathematics of conduction heating; Thermal processing and microbial death curves; Homogenization, Emulsification.

Practical

Study of working principle open pan and vacuum evaporator and estimation of heat/mass balance during concentration of liquid foods; Study of single effect evaporator and estimation of heat/mass balance during concentration of liquid foods; multiple effect evaporator and estimation of heat/mass balance during concentration of liquid foods; Effect of sample particle size and time on solvent extraction process; Effect of temperature on crystallization rate of sugar. Study of freezers/ Design problems on freezers; To study freezing of foods by different methods IQF freezing; Determination of freezing time of a food material; To study simple distillation process and determine the rate of distillation; To study the process of roasting/ To study the effect of time temperature combination on roasting; Determination of oil uptake by the food product during frying. To determine the efficacy of a blanching process; time-temperature combination for a blanching process; efficacy of a sterilization process; Determination of F value for a product in can/ retort able pouch; Study of sterilizer /blancher/ pasteurizers/ fryers/ homogenizers/ irradiators.

Suggested Readings

1. Earle, R.L. 2004. Unit Operations in Food Processing. The New Zealand Institute of Food Science and Technology, New Zealand.
2. Fellows, P. 2000. Food Processing Technology: Principles and Practice, 2nd edn. CRC Press, Boca Raton, FL, USA.
3. Geankoplis, C.G. 2003. Transport Processes and Separation Process Principles (Includes Unit Operations), 4th edn. Prentice-Hall, NY, USA.
4. Ibarz, A. and Barbosa-Cánovas, G. V. 2003. Unit Operations in Food Engineering. CRC Press, Boca Raton, FL, USA.
5. McCabe, W.L., Smith, J. and Harriott, P. 2004. Unit Operations of Chemical Engineering, 7th edn. McGraw-Hill, Inc., NY, USA.
6. Pandey, H. Sharma, H.K., Chauhan, R.C., Sarkar, B.C. and Bera, M.B. 2010. Experiments in food process engineering. New Delhi: CBS Publisher and Distributors Pvt Ltd.
7. Richardson, J F., Harker, J.H. and Backhurst, J.R. 2002. Coulson and Richardson's Chemical Engineering, Vol. 2, Particle Technology and Separation Processes, 5th edn. Butterworth–Heinemann, Oxford, UK.
8. Saravacos, G.D. and Kostaropoulos, A.E. 2002. Handbook of Food Processing Equipment. Springer Science andBusiness Media, New York, USA.
9. Singh, R.P. and Heldman, D.R. 2014. Introduction to Food Engineering, 5th edn. Elsevier, Amsterdam, The Netherlands.
10. Sinnott, R.K. 1999. Chemical Engineering, Vol. 6, Chemical Engineering Design, 3rd edn. Butterworth-Heinemann, Oxford, UK.
11. Treybal, R.E. 1980. Mass Transfer Operations, 3rd edn. McGraw-Hill Book Company, Auckland, USA.
12. Valentas, K.J., Rotstein, E. and Singh, R.P. 1997. Handbook of Food Engineering Practice. CRC Press, Boca Raton, FL, USA.