Please label the file with the Department Name

Course Code	**Math (E)-1.1.1**
Course Title	**Engineering Mathematics-I**
Course Credit	**3(2+1)**
Objectives of Course	1. The goal of this course is to achieve conceptual understanding and to retain the best traditions of traditional calculus. 2. The syllabus is designed to provide the basic tools of calculus mainly for the purpose of modelling the engineering problems mathematically and obtaining solutions. 3. This is a foundation course which mainly deals with topics such as single variable and multivariable calculus and plays an important role in the understanding the problem of agricultural engineering.
Course Content	**Matrices:** Elementary transformations, rank of a matrix, reduction to normal form, Gauss-Jordon method to find inverse of a matrix, Eigen values and Eigen vectors, Cayley-Hamilton theorem, linear transformation, orthogonal transformations, diagonalization of matrices, quadratic forms. PAQ form, Echelon form, Solution of linear equations, nature of rank, using Cayley-Hamilton theorem to find inverse of A. **Differential calculus:** Taylor's and Maclaurin's expansions; indeterminate form; curvature, function of two or more independent variables, partial differentiation, homogeneous functions and Euler's theorem, composite functions, total derivatives, maxima and minima. **Integral calculus:** volumes and surfaces of revolution of curves; double and triple integrals, change of order of integration, application of double and triple integrals to find area and volume. **Vector calculus:** Differentiation of vectors, scalar and vector point functions, vector differential operator Del, Gradient of a scalar point function, Divergence and Curl of a vector point function and their physical interpretations, identities involving Del, second order differential operator; line, surface and volume integrals, Stoke's ,divergence and Green's theorems (without proofs).
References	Narayan Shanti. 2004. Differential Calculus. S. Chand and Co. Ltd. New Delhi. Narayan Shanti. 2004. Integral Calculus. S. Chand and Co. Ltd. New Delhi. Grewal B S. 2004. Higher Engineering Mathematics. Khanna Publishers Delhi. Narayan Shanti. 2004. A Text Book of Vector. S. Chand and Co. Ltd. New Delhi.
Course Outcomes	At the end of the course, learners will be able **CO1**:Use both the limit definition and rules of differentiation to differentiate functions, apply L'Hospital's rule to solve indeterminate forms. **CO2**: Apply partial differentiation to solve maxima and minima problems. **CO3**: Apply integration to compute multiple integrals, area, volume, integrals in polar coordinates, in addition to change of order and change of variables. **CO4:** Matrix Algebra is one of the powerful tools to handle practical problems arising in the field of engineering. **CO5:** Apply vector calculus to solve steady state flow problems.

Mapping between Cos, POs and PSOs

CO	**PO**												**PSO**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1															
CO2															
CO3															
CO4															
CO5															

Course Code	Phy (E)-101
Course Title	Engineering Physics
Course Credit	3 (2 + 1)
Objectives of Course	1. To develop a conducive environment for technical education and research with expertise in engineering problem-solving approaches in agriculture and allied sectors with adequate knowledge and skill. 2. To enhance the ability and promote all-round development of the students for formulating solutions to real-world problems pertaining to sustained agricultural productivity using modern technologies and to create a sense of social responsibility. 3. To strengthen Industry-Institution linkage with leading national and international institutions, R&D organizations and professional bodies along with other stakeholders, for promoting techno-entrepreneurship among students.
Course Content	**Course Content:** **Theory:** Dia, Paraband 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 fiber. Physical structure. Basic theory. Mode type, input output characteristics of optical fiber 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.

References	1. Brijlal and Subrahmanyam. Text Book of optics. S. Chand and Co., New Delhi. 2. Sarkar Subir Kumar. Optical State Physics and Fiber Optics. S. Chand and Co., New Delhi. 3. Gupta S L, Kumar V Sharma R C. Elements of Spectroscopy. Pragati Prakasam, Meeruth. 4. Saxena B S and Gupta R C. Solid State Physics. Pragati Prakasam, Meeruth. 5. Srivastava B N. Essentials of Quantum Mechanics. Pragati Prakasam, Meeruth. **6.** Vasudeva D N. Fundamentals of Magnetism and Electricity. S. Chand and Co., New Delhi.
Course Outcomes	At the end of the course, learners will be able to **CO1**: Gain knowledge of new concept in the solution of practical oriented problems and to understand more deep knowledge about the solution to theoretical problems. **CO2**: Understand measurements technology, usage of new instruments and real time applications in engineering studies. **CO3:** Identifying and applying relevant physical laws and principles to problems. **CO4**: Developing models and articulating relevant assumptions, approximations, and limitations. **CO5**: Applying mathematical, statistical, and computational skills to develop solutions and Evaluating, assessing, and interpreting their results.

Mapping between Cos, POs and PSOs

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1															
CO2															
CO3											1				
CO4															
CO5															

Course Code	**Chem(E)-1.1.3**
Course Title	**Engineering Chemistry**
Course Credit	**3(2+1)**
Objectives of Course	1. To familiarize the students with the three main types of particle size, especially colloidal size and how their physical properties changes with size and different dispersion systems. 2. To inculcate sound understanding of water quality parameters and disadvantages of hard water in industry as well as domestic use. 3. To impart knowledge on the types of lubricant and its functions. 4. To introduce the basic concepts and applications of phase rule and composites. 5. To facilitate the understanding of important characteristics of fuels, their properties and drawbacks of different types of fuels. 6. To introduce basic introduction to main components of Food chemistry, their classification, importance and deficiency diseases. 7. To impart knowledge on Corrosion-Its causes, types and methods of prevention.

Course Content	**Theory:** Phase rule and its application to one and two component systems. Fuels: classification. Calorific value. Colloids: classification. Properties. Corrosion: causes. Types and method of prevention. Water: temporary and permanent hardness. Disadvantages of hard water, scale and sludge formation in boilers, boiler corrosion. Analytical methods like thermo-gravimetric. Polarographic analysis. Nuclear radiation. Detectors and analytical applications of radioactive materials. Enzymes and their use in the manufacturing of ethanol and acetic acid by fermentation methods. Principles of food chemistry. Introduction to lipids, proteins, carbohydrates, vitamins, food preseltators, colouring and flavouring reagents of food. Lubricants properties mechanism. classification and tests. Polymers. Types of polymerization. properties. Uses and methods for the determination of molecular weight of polymers. Introduction to IR spectroscopy. **Practical:** Determination of temporary and permanent hardness of water by EDTA method: Estimation of chloride in water: Estimation of dissolved oxygen in water: Determination of BOD in water sample: Determination of COD in water sample: Estimation of available chlorine in bleaching powder: Determination of viscosity of oil: Estimation of activity of water sample: Estimation of alkalinity of water sample Determination of carbonate and non- carbonate hardness by soda reagent: Determination of coagulation of water and chloride ion content: Determination of specific rotation of an optically active compound: Determination of Xnax and verification of Beer Lambert Law: Determination of calorific value of fuel: Identification of functional groups (alcohol, aldelyde, ketones, carboxylic acid and a mide) by IR: Chromatographic analysis: Determination of molar refraction of organic compounds.
References	Jain P L and Jain M. 1994. Engineering Chemistry. Danpat Rai publishing company Pvt. Ltd., Delhi. Bahl B S, Arun Bahl and Tuli B D. 2007. Essentials of Physical Chemistry. S.Chand and Co. Ltd., Delhi
Course Outcomes	At the end of the course, learners will be able **CO1**: To analyse the quality of water samples with respect to their hardness, acidity, alkalinity and DO. **CO2**: Ability to Identify various functional group (alcohol, aldelyde, ketones, carboxylic acid and amid e) by IR. **CO3:**Develop familiarity with the basic food components like Vitamins, Carbohydrates, Proteins ,Enzymes **CO4**: Ability to differentiate different types of polymers and its applications in day to day use and industrial applications. **CO5**:To judge the quality of fuel.

Mapping between Cos, POs and PSOs

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1															
CO2															
CO3															
CO4															
CO5															

Course Code	**Ag(E)-1.1.4**
Course Title	**Principles of Soil Science**
Course Credit	**3(2+1)**
Objective of Course	1) To expose the students to the fundamental knowledge on Soil physical parameters, Permeability – Compaction, Bearing Capacity and types and methods of soil survey and interpretative groupings 2) Students should be able to verify various quality aspects of soil and water studied in theory by performing experiments in the laboratory.
Course Content	**Theory:** Nature and origin of soil; soil forming rocks and minerals, their classification and composition, soil forming processes, classification of soils – soil taxonomy orders; important soil physical properties; and their importance; soil particle distribution; soil inorganic colloids – their composition, properties and origin of charge; ion exchange in soil and nutrient availability; soil organic matter – its composition and decomposition, effect on soil fertility; soil reaction – acidic, saline and sodic soils; quality or irrigation water; essential plants nutrients – their functions and deficiency symptoms in plants; important inorganic fertilizers and their reactions in soils. Use of saline and sodic water for crop production, Gypsum requirement for reclamation of sodic soils and neutralising RSC; Liquid fertilisers and their solubility and compatibility. **Practical:** Identification of rocks and minerals; Examination of soil profile in the field; Collection of Soil Sample; Determination of bulk density; particle density and porosity of soil; Determination of organic carbon of soil; Determination of Nitrogen, Determination of Phosphorus and Determination of Potassium; Identification of nutrient deficiency symptoms of crops in the field; Determination of gypsum requirement of sodic soils; Determination of water quality parameters.
References:	Brady Nyle C and Ray R Well. 2002. Nature and properties of soils. Pearson Education Inc., New Delhi. Indian Society of Soil Science. 1998. Fundamentals of Soil Science. IARI, New Delhi. Sehgal J.. A. Textbook of Pedology Concepts and Applications. Kalyani Publishers, New Delhi. Hillel D. 1982. Introduction to Soil Physics. Academic Press, London.
Course Outcomes	At the end of the course, learners will be able **CO1**: To understand the fundamental knowledge of soil physical parameters. **CO2**: To Perform a soil survey and classify soil based on its characteristics and explain the phase relationship and soil compaction. **CO3**: To explain soil physical properties and compare the properties based on soil and water system **CO4**: To analyse the soil chemical properties to classify the arable and problem soils to develop different reclamation practices **CO5** – To analyse the Engineering properties of soil and Understand Concepts of bearing capacity and slope stability.

Mapping between Cos, POs and PSOs

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1															
CO2															
CO3															
CO4															
CO5															

Course Code	**CE-1.1.5**
Course Title	**Surveying and Levelling**
Course Credit	**3(1+2)**
Objectives of Course	• Understand conventional and modern methods of surveying. • Develop ability to transform basic concept of surveying to field practice. • Interpret plans and maps for planning and setting out works. • Understand modern surveying techniques for mapping.
Course Content	**Course Content:** **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. Introductio n 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.
References	• Punmia,B C 1987. Surveying (Vol.I). Laxmi Publications, New Delhi. • Arora K R 1990. Surveying (Vol.I), Standard Book House, Delhi. • Kanetkar T P 1993. Surveying and Levelling. Pune Vidyarthi Griha, Prakashan, Pune.
Course Outcomes	At the end of the course, learners will be able **CO1**: Use conventional instruments to map the parcels of land. **CO2**: Show effectiveness of modern surveying instruments to improve accuracy and to save time and for surveying operations. **CO3:** Analyze the problems of computation of area and volume, setting out of curves and works using surveying knowledge. **CO4:** Appreciate the use of modern techniques for surveying and mapping

Mapping between Cos, POs and PSOs

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1															
CO2															
CO3															
CO4															

Course Code	**CE-1.1.6**
Course Title	**Engineering Mechanics**
Course Credit	**3(2+1)**
Objectives of Course	1. To understand the concept of basic engineering mechanism. 2. Understand the force systems and draw free body diagram to analyze rigid body equilibrium. 3. Comprehend the principles of friction and solve engineering mechanics problems associated with frictional force. 4. Compute the centroid, first moment and second moment of an area. 5. Understand the concept of motion of particles and rigid bodies.
Course Content	**Course Content:** **Theory:** Basic concepts of Engineering Mechanics. Force systems, Centroid, Moment of inertia, Free body diagram and equilibrium of forces. Frictional forces Analysis of simple framed structures using methods of joints, methods of sections and graphical method. Simple stresses. Shear force and bending moment diagrams. Stresses in beams. Torsion. Analysis of plane and complex stresses. **Practical:** Problems on composition and resolution of forces, moments of a force, couples, transmission of a couple, resolution of a force into a force & a couple; Problems relating to resultant of; Co-planer force system, collinear force system, concurrent force system, co-planer concurrent force system, co-planer non - concurrent force system, Non-coplaner concurrent force system, Non-coplaner non-concurrent force system, system of couples in space; Problems relating to centroids of composite areas; Problems on moment of inertia, polar moment of inertia, radius of gyration, polar radius of gyration of composite areas; Equilibrium of concurrent – co-planer and non - concurrent – co-planer force systems; Problems involving frictional forces; Analysis of simple trusses by method of joints and method of sections; Analysis of simple trusses by graphical method; Problems relating to simple stresses and strains; Problems on shear force and bending moment diagrams; Problems relating to stresses in beams; Problems on torsion of shafts; Analysis of plane and complex stresses.
References	**Suggested Readings** • Sundarajan V 2002. Engineering Mechanics and Dynamics. Tata McGraw Hill Publishing Co. Ltd., New Delhi. • Timoshenko S and Young D H 2003. Engineering Mechanics. McGraw Hill Book Co., New Delhi. • Prasad I B 2004. Applied Mechanics. Khanna Publishers, New Delhi. • Prasad I B 2004. Applied Mechanics and Strength of Materials. Khanna Publishers, New Delhi. • Bansal R K 2005. A Text Book of Engineering Mechanics. Laxmi Publishers, New Delhi
Course Outcomes	At the end of the course, learners will be able **CO1**: Students will understand the concepts of engineering mechanics. **CO2**: Students will understand the vectorial representation of forces and moments. **CO3:** Students will gain knowledge regarding centre of gravity and moment of inertia and apply them for practical problems.

	CO4: Students will gain knowledge regarding various types of forces and reactions and draw free body diagram to quicker solutions for complicated problems. **CO5:** Student will gain knowledge on friction on equilibrium and its application.

Mapping between Cos, POs and PSOs

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
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CO2															
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CO4															
CO5															

Course Code	**ME 1.1.7**
Course Title	**Engineering Drawing**
Course Credit	**2 (0+2)**
Objectives of Course	1. To Develop understanding of basic rules of engineering drawing, dimensioning, drawing scales, First and third angle projections, and orthographic Projection. 2. To develop skill for projection of points, lines, planes, and solids, Sectioning 3. To equipped with drawing skill i.e. working drawing, missing views, sectional drawings. 4. Draw isometric projection and perspective views of an object/solid. 5. Introduction to various joints, fasteners, fittings and their drawing.
Course Content	Introduction of drawing scales; First and third angle methods of projection. Principles of orthographic,projections; **References** planes; Points and lines in space and traces of lines and planes; Auxiliary planes,and true shapes of oblique plain surface; True length and inclination of lines; Projections of solids (Change of position method, alteration of ground lines); Section of solids and Interpenetration of solid surfaces; Development of surfaces of geometrical solids; Isometric projection of geometrical solids. Preparation of working drawing from models and isometric views. Drawing of missing views. Different methods of dimensioning. Concept of sectioning. Revolved and oblique sections. Sectional drawing of simple machine parts. Types of rivet heads and riveted joints. Processes for producing leak proof joints. Symbols for different types of welded joints. Nomenclature, thread profiles, multi start threads, left and right hand threads. Square headed and hexagonal nuts and bolts. Conventional representation of threads. Different types of lock nuts, studs, machine screws, cap screws and wood screws. Foundation bolts. Forms of screw threads, representation of threads, Bolts- headed centre, stud screws, set screws, butt, hexagonal and square; keys-types, taper, rank taper, hollow saddle etc.
References	Bhat N D. 2010. Elementary Engineering Drawing. Charotar Publishing House Pvt. Ltd., Anand. t N D and Panchal V M. 2013. Machine Drawing. Charotar Publishing House Pvt. Ltd., Anand. Narayana K L and Kannaiah P. 2010. Machine Drawing. Scitech Publications (India) Pvt. Ltd., Chennai.
Course Outcomes	At the end of the course, learners will be able. **CO1**: Discuss about basic rules of engineering drawing, dimensioning, drawing scales, First and third angle projections, and orthographic Projection.

	CO2: Draw the projection of points, lines, planes, solid. **CO3:** Apply the concept of drawing in practical applications. **CO4:** Draw the various views and working drawings. **CO5:** Understand the application of joints, fasteners and fitting and drawings

Mapping between Cos, POs and PSOs

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
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CO2															
CO3															
CO4															
CO5															

Course Code	**ME-1.1.8**
Course Title	**Heat & Mass Transfer**
Course Credit	**2+0**
Objectives of Course	1. To develop a foundational understanding of introductory concepts in heat transfer. 2. To gain proficiency in solving the general differential equation of conduction, convection, and radiation. 3. To investigate convection processes, covering free and forced convection. 4. To develop a comprehensive understanding of radiation principles, including absorptivity, reflectivity, and transmissivity of radiation. 5. Apply heat transfer principles to analyse heat exchangers, considering fouling factors, LMTD, heat exchanger performance, and transfer units.
Course Content	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 with and without heat generation. Electrical analogy. Insulation materials. Fins, Free and forced convection. Newton's law of cooling, heat transfer coefficient in convection. Dimensional analysis of free and forced convection. Useful non dimensional numbers. Equation of laminar boundary layer on flat plate and in a tube. Laminar forced convection on a flat plate and in a tube. Combined free and forced convection. Introduction. Absorptivity, reflectivity, and transmissivity of radiation. Black body and monochromatic radiation, Planck's law, Stefan-Boltzmann law, Kirchoff's law, grey bodies and emissive power, solid angle, intensity of radiation. Radiation exchange between black surfaces, geometric configuration factor. Heat transfer analysis involving conduction, convection, and radiation by networks. Types of heat exchangers, fouling factor, log mean temperature difference, heat exchanger performance, transfer units. Heat exchanger analysis restricted to parallel and counter flow heat exchangers. Steady state molecular diffusion in fluids at rest and in laminar flow, Flick's law, mass transfer coefficients. Reynold's analogy.
References	1. Geankoplis C.J. 1978. Transport Port Processes and Unit Operations. Allyn and Bacon Inc., Newton, Massachusetts. 2. Holman J P. 1989. Heat Transfer. McGraw Hill Book Co., New Delhi. 3. Incropera F P and De Witt D P. 1980. Fundamentals of Heat and Mass Transfer. John Wiley and Sons, New York. 4. Gupta C P and Prakash R. 1994. Engineering Heat Transfer. Nem Chand and Bros., Roorkee.

Course Outcomes	At the end of the course, learners will be able **CO1**: **Applied Understanding of Heat Transfer Fundamentals:** Graduates will demonstrate an applied understanding of introductory heat transfer concepts, including modes of heat transfer and thermal conductivity, utilizing appropriate measurement techniques in practical scenarios. **CO2: Proficiency in Solving Conduction Problems:** Students will exhibit proficiency in solving the general differential equation of conduction, particularly in one-dimensional steady-state scenarios through various geometries, employing the electrical analogy for effective problem-solving. **CO3: Competence in Convection Analysis:** Graduates will showcase competence in analysing convection phenomena, understanding, and applying Newton's law of cooling, determining heat transfer coefficients through dimensional analysis, and employing non-dimensional numbers and empirical relationships in both free and forced convection scenarios. **CO4: Comprehensive Understanding of Radiation Principles:** Students will demonstrate a comprehensive understanding of radiation principles, including concepts like absorptivity, reflectivity, and transmissivity, and their application in real-world scenarios involving radiation exchange between surfaces. **CO5: Applied Knowledge in Heat Exchanger Analysis and Mass Transfer:** Graduates will apply heat transfer principles to analyse heat exchangers, considering factors like fouling, log mean temperature difference, and heat exchanger performance. Additionally, they will demonstrate an understanding of steady-state molecular diffusion in fluids, Fick's law, and mass transfer coefficients, applying this knowledge to real-world scenarios in heat exchanger design and mass transfer processes.

Mapping between Cos, POs and PSOs

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1															
CO2															
CO3															
CO4															
CO5															

Course Code	**Math (E)-1.2.1**
Course Title	**Engineering Mathematics-II**
Course Credit	**3(2+1)**
Objectives of Course	1. This course is designed to cover topics such as Differential equation, Complex Analysis, Fourier series and Partial differential equation. 1) Apply various techniques in solving differential equations. 2) The Fourier Series finds its application in agricultural engineering for measuring the acceleration of its vehicles, gauging distance covered, and estimating fuel consumption. 3) Partial differential equations are used to model many physical phenomena, including fluid dynamics, heat transfer, and structural mechanics
Course Content	**Ordinary differential equations:** Exact and Bernoulli's differential equations, equations reducible to exact form by integrating factors, equations of first order and higher degree, Clairaut's equation, Differential equations of higher orders, methods of finding complementary functions and Particular integrals, method of variation of parameters, Cauchy's and Legendre's linear equations, simultaneous linear differential equations with constant coefficients, series solution techniques, Bessel's and Legendre's differential equations. Functions of a **Functions of a Complex Variable:** Limit,

	continuity and derivative of complex functions, analytic function, Cauchy-Reimann equations, conjugate functions, Harmonic functions. **Fourier series:** Infinite series and its convergence, periodic functions, Fourier series, Euler's formulae, Dirichlet's conditions, functions having arbitrary period, even and odd functions, half range series, Harmonic analysis. **Partial differential equations:** Formation of partial differential equations, Lagrange's linear equation, Higher order linear partial differential equations with constant coefficients, solution of non-linear partial differential equations, Charpit's method, application of partial differential equations (one dimensional wave and heat flow equations, two dimensional steady state heat flow equation (Laplace equation).
References	Narayan Shanti. 2004. A Text Book of Matrices. S. Chand and Co. Ltd. New Delhi. Grewal B S. 2004. Higher Engineering Mathematics. Khanna Publishers Delhi. Ramana B V. 2008. Engineering Mathematics. Tata McGraw-Hill. New Delhi
Course Outcomes	At the end of the course, learners will be able **CO1:** Apply various techniques in solving differential equations. **CO2:** Analytic functions, C-R equations and harmonic function. **CO3:** to apply various techniques to solve fourier series**.** **CO4:** to apply various techniques in solving partial differential equations.

Mapping between Cos, POs and PSOs

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1															
CO2															
CO3															
CO4															

Course Code	**AS(E)-1.2.2**
Course Title	**Environmental Science and Disaster Management**
Course Credit	**3(2+1)**
Objectives of Course	1. Understand and evaluate the global scale of environmental problems; and. Reflect critically on their roles, responsibilities, and identities as citizens. 2. To learn how the natural world works, to understand how humans interact with the environment, and to find ways to deal with environmental problems and live more sustainably. 3. Introduce the risk of disasters caused by human error, deliberate destru and building or equipment failures. 4. Prevent environmental impacts generated by an organization's activities, services or products. 5. Introducing Disaster Management in the curriculum will help the youth understand how to anticipate, absorb and adapt to such events. 6. To inculcate four R's- Reduction, readiness, response and recovery.
Course Content	**Theory:** ***Environmental Studies:***Scope and importance. Natural Resou rces: Renewable and non- renewable resources Natural resources and associated problems. a) Forest resources: Use and over- exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forest and tribal people. b) Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems. c) Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies. d) Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies. e) Energy

	resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources. Case studies. f) Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification. Role of an individual in conservation of natural resources. Equitable use of resources for sustainable lifestyles. Ecosystems: Concept, Structure, function, Producers, consumers, decomposers, Energy flow, ecological succession, food chains, food webs, ecological pyramids. Introduction, types, characteristic features, structure and function of the forest, grassland, desert and aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries). Biodiversity and its conservation:- Int roduction, definition, genetic, species & ecosystem diversity and bio-geographical classification of India. Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values. Biodiversity at global, National and local levels, India as a mega-diversity nation. Hot-sports of biodiversity. Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts. Endangered and endemic species of India. Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity. Environmental Pollution: definition, cause, effects and control measures of a. Air pollution b. Water pollution c. Soil pollution d. Marine pollution e. Noise pollution f. Thermal pollution g. Nuclear hazards. Solid Waste Management: causes, effects and control measures of urban and industrial wastes. Role of an individual in prevention of pollution. Pollution case studies. Social Issues and the Environment from Unsustainable to Sustainable development, Urban problems related to energy. Water conservation, rain water harvesting, watershed management. Environmental ethics: Issues and possible solutions, climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. dies. Wasteland reclamation. Consumerism and waste products. Environment Protection Act. Air (Prevention and Control of Pollution) Act. Water (Prevention and control of Pollution) Act. Wildlife Protection Act. Forest Conservation Act. Issues involved in enforcement of environmental legislation. Public awareness. Human Population and the Environment: population growth, variation among nations, population explosion, Family Welfare Programme. Environment and human health: Human Rights, Value Education, HIV/AIDS. Women and Child Welfare. Role of Information Technology in Environment and human health. ***Disaster Management**:* Natural Disasters and nature of natural disasters, their types and effects. Floods, drought, cyclone, earthquakes, landslides, avalanches, volcanic eruptions, Heat and cold waves, Climatic change: global warming, Sea level rise, ozone depletion. Man Made Disasters- Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire, oil fire, air pollution, water pollution, deforestation, industrial waste water pollution, road accidents, rail accidents, air accidents, sea accidents. Disaster Management- Effect to migrate natural disaster at national and global levels. International strategy for disaster reduction. Concept of disaster management, national disaster management framework; financial arrangements; role of NGOs, community-based organizations and media. Central, state, district and local administration; Armed forces in disaster response; Disaster response; Police and other organizations **Practicals** Case Studies and Field work. Visit to a local area to docume nt environmental assets river/forest/grassland/hill/mountain, Visit to a local polluted site-Urban/ Rural/ Industrial/ Agricultural, study of common plants, insects, birds and study of simple ecosystems-pond, river, hill slopes, etc. Expected impact of climate change on agricultural production and water

	resources, Mitigation Strategies, Economics of climate change. Disaster Management introduction, Natural and Manmade Disaster Studies, Informatics for Disaster Management, Quantitative Techniques for Disaster Management Environmental Impact Assessment (EIA) and Disaster Management Disaster Management Policy Environmental Modelling.
References	Bharucha Erach. 2005. Text Book of Environmental Studies for Undergraduate Courses. University Grants Commission, University Press, Hyderabad. Sharma J P. 2003. Introduction to Environment Science. Lakshmi Publications. Chary Manohar and Jaya Ram Reddy. 2004. Principles of Environmental Studies. BS Publishers, Hyderabad. Kaul S N, Ashuthosh Gautam. 2002. Water and Waste Water Analysis. Days Publishing House, Delhi. Gupta P K. 2004. Methods in Environmental Analysis – Water. Soil and Air. Agro bios, Jodhpur. Climate change.1995: Adaptation and mitigation of climate change- Scientific Technical Analysis Cambridge University Press, Cambridge. Sharma, R.K. & Sharma, G. 2005. Natural Disaster. APH Publishing Corporation, New Delhi. Husain Majid. 2013. Environment and Ecology: Biodiversity, Climate Change and Disaster Management. online book
Course Outcomes	At the end of the course, learners will be able **CO1**: To solve environmental issues in an inclusive manner **CO2**: Demonstrate mastery of core ecological and physical science concepts and methods as they pertain to environmental problem-solving. **CO3:** Recognize and integrate the international, cross-cultural, and transdisciplinary nature of environmental problems in analyses and solutions. CO4: Appreciate the ethical, cross-cultural, and historical context of environmental issues and the links between human and natural systems. CO5: To comprehend about causes, impact, distribution and mapping of disasters in India.

Mapping between Cos, POs and PSOs

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1															
CO2															
CO3															
CO4															
CO5															

Course Code	**AS(E)-1.2.3**
Course Title	**Entrepreneurship Development and Business Management**
Course Credit	**3(2+1)**
Objective of Course	1. To develop and strengthen the entrepreneurial quality and motivation of learners. 2. To impart the entrepreneurial skills and traits essential to become successful entrepreneurs. 3. To apply the principles and theories of entrepreneurship and management in technology-oriented businesses to empower the learners to run a Technology business efficiently and effectively
Course Content	**Theory:** Entrepreneurship, management – Management functions – planning- Organizing - Directing – motivation – ordering – leading – supervision-Communication and control – Capital – Financial management – importance of financial statements – balance sheet – profit and loss statement, Analysis of financial statements – liquidity ratios – leverage ratios, Coverage ratios – turnover ratios – profitability ratios, Agro- based industries – Project – project cycle – Project appraisal and evaluation techniques – undiscounted measures – payback period – proceeds per rupee of outlay, Discounted measures – Net Present Value (NPV) – Benefit-Cost Ratio (BCR) – Internal Rate of Return (IRR) – Net benefit investment ratio (N / K ratio) – sensitivity analysis-Importance of agribusiness in Indian economy International trade-WTO agreements – Provisions related to agreements in agricultural and food commodities. Agreements on agriculture (AOA) – Domestic supply, market access, export subsidies agreements on sanitary and phyto- sanitary (SPS) measures, Trade related intellectual property rights (TRIPS). Development (ED): Concept of entrepreneur and entrepreneurship Assessing overall business environment in Indian economy– Entrepreneurial and managerial characteristics- Entrepreneurship development Programmes (EDP)- Generation incubation and commercialization of ideas and innovations- Motivation and entrepreneurship development- Globalization and the emerging business entrepreneurial environment- Managing an enterprise: Importance of planning, budgeting, monitoring evaluation and follow-up managing competition. Role of ED in economic development of a country- Overview of Indian social, political systems and their implications for decision making by individual entrepreneurs- Economic system and its implications for decision making by individual entrepreneurs- Social responsibility of business. Morals and ethics in enterprise management- SWOT analysis- Government schemes and incentives for promotion of entrepreneurship. Government policy on small and medium enterprises (SMEs)/SSIs/MSME sectors- Venture capital (VC), contract farming (CF) and joint ventures (JV), public-private partnerships (PPP)- Overview of agricultural engineering industry, characteristics of Indian farm machinery industry. **Practical:** Preparation of business – Strengths Weaknesses Opportunities and Threats (SWOT) analysis, Analysis of financial statements (Balance Sheet, Profit loss statement). Compounding and discounting, Break-even analysis Visit to agro-based industries – I, Visit to agro-based industries – II Study of Agro-industries Development Corporation , Ratio analysis – I, Ratio analysis – II, Application of project appraisal technique – I(Undiscounted measures), Application of project appraisal technique – II(Discounted Measures), Formulation of project feasibility reports – Farm Machinery Project proposals as entrepreneur – individual and group - Presentation of project proposals in the class.
References:	Harsh, S.B., Conner, U.J. and Schwab, G.D. 1981. Management of the Farm Business. Prentice Hall Inc., New Jersey. Joseph, L. Massie. 1995. Essentials of Management. Prentice Hall of India Pvt. Ltd., New Delhi.

Omri Rawlins, N. 1980. Introduction to Agribusiness. Prentice Hall Inc., New Jersey
Gittenger Price, J. 1989. Economic Analysis of Agricultural Projects. John Hopkins University, Press, London.
Thomas W Zimmer and Norman M Scarborough. 1996. Entrepreneurship. Prentice-Hall, New Jersey. Mark J Dollinger. 1999. Entrepreneurship Strategies and Resources. Prentice-Hall, Upper Saddal Rover, New Jersey.
Khanka S S. 1999. Entrepreneurial Development. S. Chand and Co. New Delhi.
Mohanty S K. 2007. Fundamentals of Entrepreneurship. Prentice Hall India Ltd., New Delhi.

Course Outcomes

At the end of the course, learners will be able
CO1: Learn the basics of Entrepreneurship
CO2: Understand the business ownership patterns and environment
CO3: Understand the Job opportunities in Industries relating to Technopreneurship
CO4: Learn about applications of tehnopreneurship and successful technopreneurs
CO5: Acquaint with the recent and emerging trends in entrepreneurship

Mapping between Cos, POs and PSOs

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1															
CO2															
CO3															
CO4															
CO5															

Course Code	**C.E.1.2.4**
Course Title	**Fluid Mechanics and Open Channel Hydraulics**
Course Credit	**3(2+1)**
Objectives of Course	1. Grasp the fundamental principles governing fluid behavior, encompassing pressure, buoyancy, fluid motion, and dynamics of flow. 2. Understand various flow types, fluid forces on surfaces, and factors influencing fluid motion in pipes and open channels. 3. Comprehend the significance of dimensional analysis, similitude, and the basics of fluid machinery. 4. Gain practical skills in utilizing instruments for pressure measurement and verifying fluid mechanics principles through experimental setups. 5. Apply theoretical knowledge to practical scenarios, evaluating coefficients, forces, efficiencies, and performance of hydraulic machinery.
Course Content	**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 ime),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, Hydraulic jump; Dimensional analysis and similitude: Rayleigh's method and Buckingham's `Pi' theorem, types of similarities, dimensional analysis, dimensionless numbers. 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; Measurement of force exerted by water jets on flat and hemispherical vanes; Determination of meta-centric height; Determination of efficiency of hydraulic ram; Performance evaluation of Pelton and Francis turbine; Study of current meter; Velocity distribution in open channels and determination of Manning's coefficient of rugosity.
References	• Sundarajan V 2002. Engineering Mechanics and Dynamics. Tata McGraw Hill Publishing Co. Ltd., New Delhi. • enko S and Young D H 2003. Engineering Mechanics. McGraw Hill Book Co., New Delhi. • Prasad I B 2004. Applied Mechanics. Khanna Publishers, New Delhi. • Prasad I B 2004. Applied Mechanics and Strength of Materials. Khanna Publishers, New Delhi. Bansal R K 2005. A Text Book of Engineering Mechanics. Laxmi Publishers, New Delhi
Course Outcomes	At the end of the course, learners will be able 1. Mastery of fundamental fluid principles for analyzing pressure, forces, and fluid motion. 2. Competency in assessing different flow types and dynamics in pipes and open channels. 3. Application of dimensional analysis and similitude in fluid mechanics problem-solving. 4. Proficiency in utilizing instruments for pressure measurement and verifying fluid mechanics theories through experiments. **5.** Ability to evaluate coefficients and performance parameters of hydraulic machinery, bridging theory with practical applications in fluid mechanics.

Mapping between Cos, POs and PSOs

CO	**PO**												**PSO**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1															
CO2															
CO3															
CO4															
CO5															

Course Code	**C.E.1.2.5**
Course Title	**Strength of Materials**
Course Credit	**2(1+1)**
Objectives of Course	1. Master methods for analyzing slope and deflection of beams, including integration techniques and moment area theorems. 2. Understand the behavior and analysis of columns, struts, and different types of connections like riveted and welded connections. 3. Grasp the stability principles and analysis techniques for masonry dams. 4. Learn advanced beam analysis methods, including statically intermediate beams, propped beams, and fixed/continuous beam analysis using various methods. 5. Apply theoretical knowledge to practical scenarios, evaluating structural stability and behavior of different beam configurations
Course Content	**Theory** Slope and deflection of beams using integration techniques, moment area theorems and conjugate beam method. Columns and Struts. Riveted and welded connections. Stability of masonry dams. Analysis of statically intermediate beams. Propped beams. Fixed and continuous beam analysis using superposition, three moment equation and moment distribution methods. **Practical** To perform the tension test on metal specimen (M.S., C.I.), to observe the behavior of materials under load, to calculate the value of E, ultimate stress, permissible stress, percentage elongation etc. and to study its fracture; To perform the compression test on; Concrete cylinders &cubes, C.I., M.S. & Wood specimens and to determine various physical and mechanical properties; To perform the bending test on the specimens; M.S. Girder, Wooden beam, Plain concrete beams & R.C.C. beam, and to determine the various physical and mechanical properties; To determine Young's modulus of elasticity of beam with the help of deflection produced at centre due to loads placed at centre & quarter points; To study the behaviour of materials (G.I. pipes, M.S., C.I.)under torsion and to evaluate various elastic constants; To study load deflection and other physical properties of closely coiled helical spring in tension and compression; To perform the Rockwell, Vicker's and Brinell's Hardness tests on the given specimens; To perform the Drop Hammer Test, Izod Test and Charpay's impact tests on the given specimens; To determine compressive & tensile strength of cement after making cubes and briquettes; To measure workability of concrete (slump test, compaction factor test); To determine voids ratio & bulk density of cement, fine aggregates and coarse aggregates; To determine fatigue strength of a given specimen; To write detail report emphasizing engineering importance of performing tension, compression, bending, torsion, impact and hardness tests on the materials.
References	• Khurmi R.S. 2001. Strength of Materials S. Chand & Co., Ltd., New Delhi. • Junarkar S.B. 2001.Mechanics of Structures (Vo-I). Choratar Publishing House, Anand. • Ramamrutham S. 2003. Strengths of Materials. Dhanpat Rai and Sons, Nai Sarak, New Delhi.
Course Outcomes	At the end of the course, learners will be able CO1: Proficiency in analyzing beam deflection and slope using integration, moment area theorems, and conjugate beam methods. CO2: Competency in analyzing columns, struts, and various connections in structural systems. CO3: Understanding of stability principles and analysis methods for masonry dams. CO4: Mastery of advanced beam analysis techniques for various beam configurations.

	CO5: Application of theoretical knowledge to assess structural stability and behavior in real world scenarios.

Mapping between Cos, POs and PSOs

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1															
CO2															
CO3															
CO4															
CO5															

Course Code	**ME-1.2.6**
Course Title	**Workshop Technology and Practices**
Course Credit	**1+2**
Objectives of Course	1. To familiarize students with various carpentry tools, types of wood, and their characteristics. 2. Introduce students to the tools and operations in a smithy, covering the basics of metalworking and forging processes. 3. To introduce welding, types of welding, oxyacetylene gas welding, flame types, welding techniques, and equipment. 4. To equip students with knowledge about classification, constructional details, main accessories, and attachments of a lathe machine. 5. To develop understanding Shapers, Drilling Machines, and Milling Machines.
Course Content	Introduction to various carpentry tools, materials, types of wood and their characteristics and Processes or operations in wood working; Introduction to Smithy tools and operations; Introduction to welding, types of welding, Oxyacetylene gas welding, types of flames, welding techniques and equipment. Principle of arc welding, equipment, and tools. Casting processes; Classification, constructional details of centre lathe, Main accessories, and attachments. Main operations and tools used on centre lathes. Types of shapers, Constructional details of standard shaper. Work holding devices, shaper tools and main operations. Types of drilling machines. Constructional details of pillar types and radial drilling machines. Work holding and tool holding devices. Main operations. Twist drills, drill angles and sizes. Types and classification. Constructional details and principles of operation of column and knee type universal milling machines. Plain milling cutter. Main operations on milling machine.
References	1. Workshop Technology Vol. I & II , By: S.K. Hajra Chaudhary 2. Workshop Technology , By: Chapman 3. Workshop Technology , By: S.K. Gupta 4. Manufacturing Technology, By: S. Dalela
Course Outcomes	At the end of the course, learners will be able **CO1**: **Proficiency in Carpentry Techniques:** Graduates will demonstrate proficiency in using various carpentry tools, understanding different wood types and their characteristics, and applying processes and operations in woodworking, ensuring the ability to undertake carpentry tasks with precision. **CO2: Competence in Smithy Operations:** Students will exhibit competence in using smithy tools and performing basic metalworking operations, acquiring the skills needed for forging and shaping metals in a smithy environment. **CO3: Foundational Knowledge in Welding:** Graduates will possess foundational knowledge in welding, covering various welding types, oxyacetylene gas welding, flame types, and arc welding principles, enabling them to undertake basic welding tasks and comprehend welding processes.

	CO4: Effective Operation of Lathe Machines: Students will demonstrate effective operation of centre lathes, including knowledge of their classification, constructional details, accessories, and attachments. They will also showcase proficiency in using main operations and tools associated with centre lathes. **CO5: Understanding of Shapers, Drilling Machines, and Milling Machines:** Graduates will exhibit a comprehensive understanding of shapers, drilling machines, and milling machines, including their constructional details, work holding devices, tool holding devices, and main operations. This knowledge prepares them for a range of machining tasks in manufacturing and fabrication settings.

Mapping between Cos, POs and PSOs

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1															
CO2															
CO3															
CO4															
CO5															

Course Code	**ME 1.2.7**
Course Title	**Theory of Machines**
Course Credit	**2 (2+0)**
Objectives of Course	1. To explain the principles of kinematic chain, pairs, mechanisms, Inversion, Compute velocity and acceleration in mechanisms. 2. To study various power transmission drives gears, gear trains, belt drives, chain drives, friction. 3. To study different types of governors and classification 4. To study balancing, classification of balancing
Course Content	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. Determination of velocity and acceleration using graphical (relative velocity and acceleration) method. Instantaneous centers. Types of gears. Law of gearing, velocity of sliding between two teeth in mesh. Involute and cycloidal profile for gear teeth. Spur gear, nomenclature, interference and undercutting. 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, power transmitted, velocity ratio, belt size for flat and V belts. Effect of centrifugal tension, creep and slip on power transmission, Chain drives. Types of friction, laws of dry friction. Friction of pivots and collars. Single disc, multiple disc, and cone clutches. Rolling friction, anti-friction bearings. Types of governors. Constructional details and analysis of Watt, Porter, Proell governors. Effect of friction, controlling force curves. Sensitiveness, stability, hunting, iso-chronism, power and effort of a governor. Static and dynamic balancing. Balancing of rotating masses in one and different planes.
References	Bhat Bevan Thomas. 1984. Theory of Machines. CBS Publishers and Distributors, Delhi. Ballaney P L. 1985. Theory of Machines. Khanna Publishers, 2-B Nath Market, Nai Sarak, New Delhi. Rao J S and Dukkipatti R V. 1990. Mechanisms and Machine Theory. Wiley astern Ltd., New Delhi.

	Lal Jagdish. 1991. Theory of Mechanisms and Machines. Metropolitan Book Co. Pvt.Ltd., 1 Netaji Subash Marg, New Delhi.. Rattan S B. 1993. Theory of Machines. Tata McGraw Hill Publishing Co. Ltd., 12/4 Asaf Ali Road, New Delhi. Khurmi R S and Gupta J K. 1994. Theory of Machines. Eurasia Publishing House Pvt. Ltd., Ram Nagar, New Delhi.
Course Outcomes	At the end of the course, learners will be able. **CO1**: To explain the principles of kinematic chain, pairs, mechanisms, Compute velocity and acceleration in planar mechanisms. Apply the concepts of kinematics in predicting motion mechanism for given application. **CO2**: Compute the gear terminology suitable for given application, power transmission and drives. **CO3:** Apply the concept of governor and its terminology. **CO4:** Apply the concepts of static and dynamic balancing for different conditions.

Mapping between Cos, POs and PSOs

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1															
CO2															
CO3															
CO4															

Course Code	**CSE-1.2.8**
Course Title	**Web Designing and Internet Applications**
Course Credit	**2 (1 + 1)**
Objectives of Course	1. To impart the knowledge of the Internet. 2. To impart the knowledge of the HTML 3. To study fundamentals of JavaScript development. 4. To design a website
Course Content	**Theory:** Basic principles in developing a web designing, Planning process, Five Golden rules of web designing, Designing navigation bar, Page design, Home Page Layout , Design Concept. Basics in Web Design, Brief History of Internet, World Wide Web, creation of a web site, Web Standards, Audience requirement. Introduction to JavaScript, variables & functions, Working with alert, confirm and prompt, Connectivity of Web pages with databases; Project **Practical:** FLASH: Animation concept FPS, Understanding animation for web, Flash interface, Working with tools, DREAM WEAVER :Exploring Dreamweaver Interface, Planning & Setting Web Site Structure, Working with panels, Understanding and switching views, Using property inspector, Formatting text, JAVA SCRIPT: Working with alert, confirm and prompt, Understanding loop, arrays, Creating rollover image, Working with operator, GIF ANIMATION: Learning to use FTP, Setting FTP, Uploading of site, Using Control panel, FTP UPLOADING SITE: Understanding gif animation interface, Knowing GIf file format, Creating basic web banners, Creating web banners with effects, Creating animated web buttons
References	▪ Jennifer Niederst Robbins. Developing web design latest edition. ▪ Frain and Ben. Responsive Web Design with HTML5.. ▪ Nicholas c.Zakas. Java Script for Web Developers. ▪ George Q. Huang, K. L Mak. Internet Applications in Product Design and Manufacturing. ISBN:3540434658.

Course Outcomes	At the end of the course, learners will be able **CO1**: to have knowledge of Internet and HTML. **CO2**: to carry out web page development using HTML. **CO3**: to carry out web page development using JavaScript.

Mapping between Cos, POs and PSOs

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1															
CO2															
CO3															

Course Code	**Ag(E)-2.3.1**
Course Title	**Principles of Horticultural Crops and Plant Protection**
Course Credit	**2(1 + 1)**
Objective of Course	1. to expose the students on the scope of horticultural crops and floricultural crops with its improved varieties and requirements of climatic conditions 2. To express the students to achievements of knowledge of criteria of side selection layout and planting methods with proper fertilizer management 3. Student should be able to get knowledge on seed rate, planting time, Seed treatment for vegetable crops grown in trimming as well as all the agronomical reptiles is beginning from transplanting to harvesting and post harvest management with proper marketing
Course Content	**Theory:** Scope of horticultural. Soil and climatic requirements for fruits, vegetables and floriculture crops, improved varieties, Criteria for site selection, layout and planting methods, nursery raising, commercial varieties/hybrids, sowing and planting times and methods, seed rate and seed treatment for vegetable crops; macro and micro propagation methods, plant growing structures, pruning and training, crop coefficients, water requirements and critical stages, fertilizer application, fertigation, irrigation methods, harvesting, grading and packaging, post harvest practices, Garden tools, management of orchard, Extraction and storage of vegetables seeds. Major pests and diseases and their management in horticulture crops. **Practical:** Judging maturity time for harvesting of crop; Study of seed viability and germination test; Identification and description of important fruits, flowers and vegetable crops; Study of different garden tools; Preparation of nursery bed; Practices of pruning and training in some important fruit crops, visit to commercial greenhouse/ polyhouse; cultural operations for vegetable crops (sowing, fertilizer application, mulching, irrigation and weed control); seed extraction techniques; identification of important pests and diseases and their control.
References	Bansal. P.C. 2008. Horticulture in India. CBS Publishers and Distributors, New Delhi. Saraswathy, S., T.L.Preethi, S.Balasubramanyan, J. Suresh, N.Revathy and S.Natarajan. 2007. Postharvest management of Horticultural Crops. Agrobios Publishers, Jodhpur. Arjunan, G., Karthikeyan, G, Dinakaran , D. and Raguchander, T. 1999. Diseases of Horticultural Crops. AE Publications, Coimbatore. Sharma Neeta and Mashkoor Alam. 1997. Postharvest diseases of Horticultural crops. International Book publishing Co. UP.
Course Outcomes	At the end of the course, learners will be able **CO1**: To understand the fundamental knowledge of horticultural and floricultural crops **CO2**: To identify the various seats of vegetable crops and floricultural and horticultural crops **CO3**: To achieve the knowledge on various garden tools pruning and triming various paste and diseases and its control in greenhouse polyhouse Orchard management etc

Mapping between Cos, POs and PSOs

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1															
CO2															
CO3															

Course Code	**Ag(E)-2.3.2**
Course Title	**Principles of Agronomy**
Course credit	**3(2 + 1)**
Objective of Course	1. To exposed the students to the fundamental knowledge of agriculture and agronomical aspects beginning from sowing of crops to the harvesting of the same 2. 2. Student should be able to identify different classification of crops and no house of weather parameters crops sessions tillage and soil water plant relationship 3. 3. To xpose the students on weeds and its control crop rotation cropping system relay cropping as well as application of manures and fertilizers and calculation of the same
Course Content	**Theory:** Introduction and scope of agronomy. Classification of crops, Effect of different weather parameters on crop growth and development. Principles of tillage, tilth and its characteristics. Crop seasons. Methods, time and depth of sowing of major field crops. Methods and time of application of manures and fertilizers. Organic farming-Sustainable agriculture. Soil water plant relationship, crop coefficients, water requirement of crops and critical stages for irrigation, weeds and their control, crop rotation, cropping systems, Relay cropping and mixed cropping. **Practical:** Identification of crops and their varieties, seeds, manures, fertilizers and weeds; Fertilizer application methods; Different weed control methods; Practice of ploughing, Practice of Puddling, Practice of sowing.
References:	Identification of crops and their varieties, seeds, manures, fertilizers and weeds; Fertilizer application methods; Different weed control methods; Practice of ploughing, Practice of Puddling, Practice of sowing.
Course Outcomes	At the end of the course, learners will be able **CO1**: To understand the fundamental knowledge of agriculture and agronomical aspects **CO2:** To identify the seed of different crops vs serials pulses oil seeds cash crops vegetable crops spices and condiments etc. **CO3 T**o identify the different chemical fertilizers and manure as well as the calculation as per the requirements of different crops **CO4 T**o achieve the knowledge on sustainable agriculture intercropping mixed cropping and integrated farming system **CO5** To have awareness regarding weeds and its control

Mapping between Cos, POs and PSOs

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1															
CO2															
CO3															
CO4															
CO5															

Course Code	**AS(E)-2.3.3**
Course Title	**Communication Skills & Personality Development**
Course Credit	**2 (1+1)**
Objectives of Course	1. To improve the communicative competence of learners by using basic grammatic structures in suitable contexts 2. To develop analytical thinking skills for problem-solving in communicative contexts 3. To help learners use language effectively in professional contexts 4. To read and write definitions, descriptions, narrations and essays on various topics
Course Content	**Theory:** Communication Skills: Structural and functional grammar; meaning and process of communication, verbal and non-verbal communication; listening and note taking, writing skills, oral presentation skills; field diary and lab record; indexing, footnote and bibliographic procedures. Reading and comprehension of general and technical articles, precis writing, summarizing, abstracting; individual and group presentations, impromptu presentation, public speaking; Group discussion. Organizing seminars and conferences. **Practical** Listening and note taking, writing skills, oral presentation skills; field diary and lab record; indexing, footnote and bibliographic procedures. Reading and comprehension of general and technical articles, precis writing, summarizing, abstracting; individual and group presentations.
References	Balasubramanian T. 1989. A Text book of Phonetics for Indian Students. Orient Longman, New Delhi. Balasubrmanyam M. 1985. Business Communication. Vani Educational Books, New Delhi. Naterop, Jean, B. and Rod Revell. 1997. Telephoning in English. Cambridge University Press, Cambridge. Mohan Krishna and Meera Banerjee. 1990. Developing Communication Skills. Macmillan India Ltd. New Delhi. Krishnaswamy,. N and Sriraman, T. 1995. Current English for Colleges. Macmillan India Ltd. Madras. Narayanaswamy V R. 1979. Strengthen your writing. Orient Longman, New Delhi. Sharma R C and Krishna Mohan. 1978. Business Correspondence. Tata Mc Graw Hill publishing Company, New Delhi.
Course Outcomes	At the end of the course, learners will be able **CO1**: to effectively communicate and articulate in English Communications **CO2**: To gain an understanding of basic grammatical structures and use them in the right context **CO3**: To write definitions, descriptions, narrations and essays on various topics **CO4**: To read and interpret information presented in tables, charts and other graphic forms **CO5**: To have understanding to write reports, research papers, dissertations, etc.

Mapping between Cos, POs and PSOs

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1															
CO2															
CO3															
CO4															
CO5															

Course Code	**Math (E)-2.3.4**
Course Title	**Engineering Mathematics-III**
Course Credit	**3(2+1)**
Objectives of Course	1. This course is designed to cover topics such as Numerical analysis and Laplace transform. 2. This course aims at providing the necessary basic concepts of numerical analysis and give procedures for solving numerically different kinds of problems occurring in agricultural engineering and technology. 3. To introduce the numerical techniques of interpolation in various intervals and numerical techniques of differentiation and integration which plays an important role in agricultural engineering and technology. 4. The various methods of complex analysis and Laplace transforms can be used for efficiently solving the problems that occur in agricultural engineering and technology. 5. To acquaint the knowledge of various techniques and methods of solving ordinary differential equations through numerical methods.
Course Content	**Numerical analysis :** Finite differences, various difference operators and their relationships, factorial notation, interpolation with equal intervals, Newton's forward and backward interpolation formulae, Bessel's and Stirling's central difference interpolation formulae, interpolation with unequal intervals, Newton's divided difference formula, Lagrange's interpolation formula; numerical differentiation, differentiation based on equal interval interpolation, first and second order derivatives by using Newton's forward and backward, Stirling's and Bessel's formulae; maxima and minima of a tabulated function, numerical integration, numerical integration by Trapezoidal, Simpson's and Weddle's rules; Difference equations, order of a difference equation, solution of linear difference equation, rules for finding complimentary function and particular integral; numerical solution of ordinary differential equations by Picard's method, Taylor's series method, Euler's method, modified Euler's method, Runge-Kutta method. **Laplace transforms:** Definition of Laplace transform, Laplace transforms of elementary functions, properties of Laplace transforms, inverse Laplace transforms, transforms of derivatives, integrals, transform of function multiplied by tn, transform of function divided by t, convolution theorem; application of Laplace transforms to solve ordinary differential equations and simultaneous differential equations, Laplace transforms of unit step function, unit impulse function, periodic function. **Statistics:** Testing of Hypothesis-Level of Significance-Degrees of freedom-Statistical errors, Large sample test(Z-test), Small sample test t-test(One tailed, two tailed and Paired tests), Testing of Significance through variance (F-test), Chi-Square test, contingency table, Correlation, Regression.
References	**Suggested Readings** Chandel SRS. A Hand book of Agricultural Statistics. Achal Praskasam Masndir, Kanpur. Agrawal B L. Basic Statistics. Wiley Eastern Ltd. New Age International Ltd. Nageswara Rao G. Statistics for Agricultural Sciences. BS Publications. Rangaswamy R. A Text Book of Agricultural Statistics. New Age Int. publications Ltd. Gupta S.C. Fundamental Applied Statistics.
Course Outcomes	At the end of the course, learners will be able **CO1:** Appreciate the numerical techniques of interpolation in various intervals and apply the numerical techniques of differentiation and integration for agricultural engineering problems. **CO2:** Apply the concept of testing of hypothesis for small and large samples in real life problems.

	CO3: Solve the partial and ordinary differential equations with initial and boundary conditions by using certain techniques with engineering applications **CO4** Laplace transform and inverse transform of simple functions, properties, various related theorems and application to differential equations with constant coefficients.

Mapping between Cos, POs and PSOs

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1															
CO2															
CO3															
CO4															

Course Code	**C.E.2.3.5**
Course Title	**Soil Mechanics**
Course Credit	**2(1+1)**
Objectives of Course	1. Understand fundamental soil mechanics principles, including soil properties and stress analysis. 2. Master seepage analysis and its practical applications in evaluating soil stability. 3. Develop proficiency in analyzing shear strength through various testing methods. 4. Apply theoretical knowledge to practical scenarios in compaction, consolidation, earth pressure analysis, and slope stability assessments. 5. Gain practical skills in geotechnical engineering for real-world problem-solving.
Course Content	**Theory** Introduction of soil mechanics, field of soil mechanics, phase diagram, physical and index properties of soil, classification of soils, effective and neutral stress, elementary concept of Boussinesq and Wester guards analysis, new mark influence chart. Seepage Analysis; Quick condition-two dimensional flow- Laplace equation, Velocity potential and stream function, Flow net construction. Shear strength, Mohr stress circle, theoretical relationship between principle stress circle, theoretical relationship between principal stress, Mohr coulomb failure theory, effective stress principle. Determination of shear parameters by direct shear test, triangle test & vane shear test. Numerical exercise based on various types of tests. Compaction, composition of soils standard and modified protector test, abbot compaction and Jodhpur mini compaction test field compaction method and control. Consolidation of soil: Consolidation of soils, one dimensional consolidation spring analogy, Terzaghi's theory, Laboratory consolidation test, calculation of void ratio and coefficient of volume change, Taylor's and Casagrande's method, determination of coefficient of consolidation. Earth pressure: plastic equilibrium in soils, active and passive states, Rankine's theory of earth pressure, active and passive earth pressure for cohesive soils, simple numerical exercises. Stability of slopes: introduction to stability analysis of infinite and finite slopes friction circle method,Taylor's stability number. **Practical** Determination of water content of soil; Determination of specific gravity of soil; Determination of field density of soil by core cutter method; Determination of field density by sand replacement method; Grain size analysis by sieving (Dry sieve analysis); Grain size analysis by hydrometer method; Determination of liquid limit by Casagrande's method; Determination of liquid limit by cone penetrometer and plastic limit; Determination of

	shrinkage limit; Determination of permeability by constant head method; Determination of permeability by variable head method; Determination of compaction properties by standard proctor test; Determination of shear parameters by Direct shear test; Determination of unconfined compressive strength of soil; Determination of shear parameters by Tri-axial test; Determination of consolidation properties of soils.
References	• Punmia B C, Jain A K and Jain A K. 2005. Soil Mechanics and Foundations. Laxmi Publications (P) Ltd. New Delhi. • Ranjan Gopal and Rao A S R. 1993. Basic and Applied Soil Mechanics. Welley Easters Ltd., New Delhi. • Singh Alam. 1994. Soil Engineering Vol. I. CBS Publishers and Distributions, Delhi.
Course Outcomes	At the end of the course, learners will be able **CO1**: Understand basic definitions, relationships and apply the knowledge to solve different geotechnical problems. **CO2**: Analyze the soil behavior under hydrostatic and hydrodynamic conditions. **CO3:** Apply the process and principles of compaction for various field situations. **CO4:** Understand the importance of soil investigation and apply it to different type of projects.

Mapping between Cos, POs and PSOs

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1															
CO2															
CO3															
CO4															

Course Code	**C.E.2.3.6**
Course Title	**Design of Structure**
Course Credit	**2(1+1)**
Objectives of Course	1. Gain knowledge related to BIS code application for structural design and analysis in steel members, connections, and trusses. 2. Analyze and design critical elements like reinforced sections, considering shear, bond, and torsion. 3. Apply design principles to create safe and efficient structural elements including beams, slabs, columns, foundations. 4. Integrate structural design expertise into agricultural structures like cattle sheds, poultry houses, rural water supply systems, and farm fencing. 5. Develop proficiency in diverse structural designs, incorporating agricultural and rural infrastructure requirements.
Course Content	**Course Content: Theory** Loads and use of BIS Codes. Design of connections. Design of structural steel members in tension, compression and bending. Design of steel roof truss. Analysis and design of singly and doubly reinforced sections, Shear, Bond and Torsion. Design of Flanged Beams, Slabs, Columns, Foundations, Retaining walls and Silos, Cattle shed, Poultry House, Rural Water Supply, Farm fencing. **Practical** Design and drawing of single reinforced beam, double reinforced beam, Design and drawing of steel roof truss; Design and drawing of one way, two way slabs,

	Design and drawing of RCC building; Design and drawing of Retaining wall. To measure workability of cement by slump test.
References	
Course Outcomes	At the end of the course, learners will be able **CO1**: Apply BIS codes to design various structural elements and connections. CO2: Master the design of steel members, trusses, and critical structural sections. CO3: Engineer diverse structures like beams, slabs, columns, foundations, walls, silos, sheds, and fencing. CO4: Implement theoretical knowledge into practical solutions for rural infrastructure, including water supply systems. CO5: Develop expertise in standardized structural design for innovative construction in agricultural and rural settings.

Mapping between Cos, POs and PSOs

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1															
CO2															
CO3															
CO4															
CO5															

Course Code	**ME-2.3.7**
Course Title	**Machine Design**
Course Credit	**2+0**
Objectives of Course	1. To understand the role and significance of design in engineering. 2. To familiarize students with common engineering materials and their mechanical properties. 3. To provide knowledge on types of loads and stresses, theories of failure, and the concept of factor of safety. 4. To instruct on the design principles of various mechanical components, including cotter joints, knuckle joints, pinned joints, turnbuckles, and welded joints subjected to static loads. 5. To enable students to use application of design principles in real world.
Course Content	Meaning of design, Phases of design, design considerations. Common engineering materials and their mechanical properties. Types of loads and stresses, theories of failure, factor of safety, selection of allowable stress. Stress concentration. Elementary fatigue and creep aspects. Cotter joints, knuckle joint and pinned joints, turnbuckle. Design of welded subjected to static loads. Design of threaded fasteners subjected to direct static loads, bolted joints loaded in shear and bolted joints subjected to eccentric loading. Design of shafts under torsion and combined bending and torsion. Design of keys. Design of muff, sleeve, and rigid flange couplings. Design of helical and leaf springs. Design of flat belt and V-belt drives and pulleys. Design of gears. Design of screw motion mechanisms like screw jack, lead screw, etc. Selection of anti-friction bearings.
References	1. Jain R K. 2013. Machine Design. Khanna Publishers, 2-B Nath Market, Nai Sarak, New Delhi. 2. Khurmi R S and Gupta J K. 2014. A Text Book of Machine Design. S. Chand & Company Ltd., New Delhi.
Course Outcomes	At the end of the course, learners will be able **CO1**: **Comprehensive Design Understanding:** Graduates will demonstrate a comprehensive understanding of design principles, including the meaning of

	design, the phases involved, and key considerations, providing a solid foundation for engineering design processes. **CO2: Informed Material Selection:** Students will exhibit the ability to make informed decisions about material selection, considering the mechanical properties of common engineering materials, ensuring optimal choices based on the requirements of the design. **CO3: Analysis of Loads and Stresses:** Graduates will be proficient in analyzing loads and stresses, applying theories of failure, calculating factors of safety, and making suitable selections of allowable stress, while understanding stress concentration, fatigue, and creep aspects in materials. **CO4: Competence in Mechanical Component Design:** Graduates will showcase competence in designing a variety of mechanical components, including joints, fasteners, shafts, keys, couplings, springs, belt drives, pulleys, gears, brackets, levers, columns, and various motion mechanisms, applying design principles effectively. **CO5: Application of Design Principles to Real-world Scenarios:** Students will demonstrate the ability to apply design principles to real-world scenarios, including the selection of antifriction bearings and the design of curved beams, crane hooks, circular rings, and screw motion mechanisms. This ensures that graduates are prepared to address practical engineering challenges across a range of applications.

Mapping between Cos, POs and PSOs

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1															
CO2															
CO3															
CO4															
CO5															

Course Code	**ME 2.3.8**
Course Title	**Thermodynamics, Refrigeration and Air Conditioning**
Course Credit	**3 (2+1)**
Objectives of Course	1. To Explain the basic concepts and laws of thermodynamics. concept of enthalpy and entropy in thermal systems 2.To explain the working of Carnot Otto, Diesel & Dual cycles 3.To Explain VCRS, VARS and refrigeration cycles. 4.Solve problems in psychrometric processes, airconditiong, Cooling load and application of cold storage.
Course Content	Thermodynamics properties, closed and open system, flow and non-flow processes, gas laws, laws of thermodynamics, internal energy. Application of first law in heating and expansion of gases in non-flow processes. First law applied to steady flow processes. Carnot cycle, Carnot theorem. Entropy, physical Concept of entropy, change of entropy of gases in thermodynamics process. Otto, diesel and dual cycles. 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,P-S,P-H diagrams,vapor compression cycles, dry and wet compression, super cooling and sub cooling. Vapour absorption refrigeration system. Common refrigerants and their properties. Design calculations for refrigeration system. Cold storage plants. 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 process. Air conditioning – principles –Type and functions of air conditioning, physiological principles in air conditioning, air distribution and duct design methods, fundamentals of design of complete air conditioning systems – humidifiers and dehumidifiers – cooling load calculations, types of air conditioners – applications. **Practical** Tutorials on thermodynamic air cycles, Study and application of P V and T S chart in refrigeration, P H chart (or) Mollier diagram in refrigeration, Numerical on air refrigeration cycle systems, Numerical on vapour compression cycle refrigeration system, Study of domestic water cooler, Study of domestic household refrigerator, Study of absorption type solar refrigeration system, Study cold storage for fruit and vegetables, Freezing load and time calculations for food materials, Determination of refrigeration parameters using refrigeration tutor – II, Numerical on design of air conditioning systems, Study of window air conditioner, Study on repair and maintenance of refrigeration and air-conditioning systems. Visit to chilling or ice making and cold storage plants.
References	Bhat Kothandaraman C P Khajuria P R and Arora S C. 1992. A Course in Thermodynamics and Heat Engines. Dhanpet Rai and Sons, 1682 Nai Sarak, New Delhi. Khurmi R S. 1992. Engineering Thermodynamics. S Chand and Co. Ltd., Ram Nagar, New Delhi. Mathur M L and Mehta F S. 1992. Thermodynamics and Heat Power Engineering. Dhanpat Rai and Sons 1682 Nai Sarak, New Delhi. Ballney P. L. 1994. Thermal Engineering. Khanna Publishers, New Delhi. Nag P K.1995. Engineering Thermodynamics. Tata McGraw Hill Publishing Co.Ltd., 12/4 Asaf Ali Raod, New Delhi.
Course Outcomes	At the end of the course, learners will be able **CO1**: To Explain basic concepts and laws of thermodynamics, refrigeration, and Air conditioning. **CO2**: To understand the working principals of various power cycles and refrigeration cycles. **CO3:** To solve numerical on VCRS, VARS and refrigeration cycles. **CO4:** Solve the numerical problems on psychrometric processes, airconditiong, Cooling load and application of cold storage.

Mapping between Cos, POs and PSOs

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1															
CO2															
CO3															
CO4															

Course Code	**EE-2.3.9**
Course Title	**Electrical Machines and Power Utilization**
Course Credit	**3 (2+1)**
Objectives of Course	1. To impart the basic knowledge about the DC, AC and Magnetic circuits. 2. To comprehend the working of various Electrical Machines. 3. To know about various power converters and electrical installations.
Course Content	**Theory:**

	Basic Concepts: Basic electrical quantities – specific resistance – temperature coefficient. Dc Circuits: Kirchhoff's laws – Thevenin, Superposition theorem – star delta transformation. Magnetic Circuits**:** Electro motive force, reluctance, laws of magnetic circuits, determination of ampere-turns for series and parallel magnetic circuits, hysteresis and eddy current losses. Dc Machines: DC Generators: Principles, operation and performance of DC machine (generator and motor), EMF and torque equations, armature reaction, commutation, excitation of DC generator and their characteristics; DC Motors: DC motor characteristics, starting of shunt and series motor, starters, speed control methods-field and armature control. AC Circuits: Single phase AC circuits: Basics – RMS and average quantities. Three phase AC circuits: Reasons for use of three phase systems – star and delta for generation and load - power factor - power and energy measurement various methods of three phase power measurement; power factor, reactive and apparent power, Concept and analysis of balanced polyphase circuits; Series and parallel resonance; Ac Machines: Transformer: Principle of working, construction of single phase transformer, EMF equation, phasor diagram on load, leakage reactance, voltage regulation, power and energy efficiency, open circuit and short circuit tests; Poly-phase induction motor: Construction, operation, phasor diagram, effect of rotor resistance, torque equation, starting and speed control methods. Single-phase induction motor: Double field revolving theory, equivalent circuit, characteristics, phase split, shaded pole motors **Practicals** To obtain load characteristics of d.c. shunt/series /compound generator; To study characteristics of DC shunt/ series motors; To study d.c. motor starters; To Perform load-test on 3 ph. induction motor & to plot torque V/S speed characteristics; To perform no-load & blocked –rotor tests on 3 ph. Induction motor to obtain equivalent ckt. parameters & to draw circle diagram; To study the speed control of 3 ph. induction motor by cascading of two induction motors, i.e. by feeding the slip power of one motor into the other motor; To study star- delta starters physically and (a) to draw electrical connection diagram (b) to start the 3 ph. induction motor using it. (c) to reverse the direction of 3 ph. I.M.; To start a 3-phase slip –ring induction motor by inserting different levels of resistance in the rotor ckt. and to plot torque –speed characteristics; To perform no load & blocked –rotor test on 1 ph. induction motor & to determine the parameters of equivalent ckt. drawn on the basis of double revolving field theory; To perform load –test on 1 ph. induction motor & plot torque –speed characteristics; To study power consumed in a three-phase circuit; Two lights in series controlled by one switch; Two lights in parallel controlled by one switch.
References	1. Thareja B L & Theraja AK. 2005. A text book of Electrical Technology. Vol. I S. Chand & Company LTD., New Delhi. 2. Theraja B L & Theraja AK 2005. A text book of Electrical Technology. Vol. II S.Chand & Company LTD., New Delhi. 3. Vincent Del Toro. 2000. Electrical Engineering Fundamentals. Prentice-Hall of India Private LTD., New Delhi. Anwani M L. 1997. Basic Electrical Engineering. Dhanpat Rai & Co.(P) LTD. New Delhi
Course Outcomes	At the end of this course students will demonstrate the ability to **CO1:** Describe the basic terminologies of DC, AC circuits. **CO2:** Define the basic concepts of Magnetic circuits and transformers. **CO3:** Predict and analyze the behavior of any circuits. **CO4:** Identify the type of electrical machine used for required application. **CO5: C**lassify various means of power conversion methodologies. **CO6:** Plan electrical wiring, earthing for house hold and commercial purposes.

Mapping between Cos, POs and PSOs

CO	PO	PSO

	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1															
CO2															
CO3															
CO4															
CO5															

Course Code	**C.E.2.4.1**
Course Title	**Building Construction and Cost Estimation**
Course Credit	**2(2+0)**
Objectives of Course	1. Understand and utilize diverse building materials effectively. 2. Learn essential building components and construction techniques. 3. Apply design concepts in agricultural and roof-based structures. 4. Develop skills in cost estimation and economic analysis for construction.
Course Content	Building Materials: Rocks, Stones, Bricks Properties and varieties of Tiles, Lime, Cement, Concrete, Sand. Glass, Rubber, Plastics, iron, Steel, Aluminium, Copper, Nickle. Timber. Building components: Lintels, Arches, stair cases, Different types of floors, Finishing: Damp Proofing and water proofing, Plastering, pointing, white washing and distempering – Painting, Building design, Design procedures, Technology, building construction, Types of agricultural buildings and related needs, application of design theory and practice to the conservation, sloped and flat roof buildings, construction economics: Preliminary estimates, Detailed Estimates of Buildings source of cost information, use of cost analyses for controlling design, Factors affecting building costs; cost evaluation of design and planning alternatives for building and estate development, Measurement and pricing, Economic methods for evaluating investments in buildings and building systems: cost-in-use, benefit-to-costs and savings-to-investment ratios, rate of return, net benefits, payback
References	• Punmia B.C. Ashok Kumar Jain and Arun Kumar Jain. Building Construction. Laxmi Publications (P) ltd., New Delhi. • Duggal S K. Building material. New Age International Publishers. • Sane Y.S. Planning and Designing of Buildings. • Rangwala S C. 1994. Engineering Materials. Charotar Publishing House, Anand. • Dutta B.N. 2000. Estimating and Costing. UBS publishers.
Course Outcomes	At the end of the course, learners will be able **CO1**: Proficiency in selecting suitable construction materials. **CO2**: Practical knowledge of building components and finishes. CO3: Application of design principles in various structures. CO4: Effective cost management and decision-making in construction projects. CO5: Holistic understanding for informed decision-making in construction endeavours.

Mapping between Cos, POs and PSOs

CO	**PO**												**PSO**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1															
CO2															
CO3															
CO4															
CO5															

Course Code	**ME-2.4.2**
Course Title	**Auto CAD Applications**
Course Credit	**0+2**

Objectives of Course	1. To Introduce the application of computers for design, providing students with an overview of CAD. 2. To study the draw and dimension tool bar in CAD, ensuring students understand its features and functions. 3. To study the OSNAP, line thickness, and format tool bar functionalities in CAD. 4. To Provide practice on mirror, offset, and array commands, as well as trim, extend, chamfer, fillet, copy, move, scale, and rotate commands. 5. To Guide students in the drawing of 2D and 3D machine parts using draw tool bars, and explore CNC machine.
Course Content	Application of computers for design. CAD - Overview of CAD window – Explanation of various options on drawing screen. Study of draw and dimension tool bar. Practice on draw and dimension tool bar. Study of OSNAP, line thickness and format tool bar. Practice on OSNAP, line thickness and format tool bar. Practice on mirror, offset and array commands. Practice on trim, extend, 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- Foot step bearing and knuckle joint. Sectioning of foot step bearing and stuffing box. Drawing of hexagonal, nut and bolt and other machine parts. Practice on 3-D commands- Extrusion and loft. Practice on 3-D commands- on sweep and press pull. Practice on 3-D Commands- revolving and joining. Demonstration on CNC machine and simple problems.
References	1. Rao P.N. 2002. CAD/CAM Principles and Applications. McGraw-Hill Education Pvt. Ltd., New Delhi. 2. Sareen Kuldeep and Chandan Deep Grewal. 2010. CAD/CAM Theory and Practice. S.Chand & Company Ltd., New Delhi. 3. Zeid Ibrahim. 2011. Mastering CAD/CAM with Engineering. McGraw-Hill Education Pvt. Ltd., New Delhi. 4. Lee Kunwoo. 1999. Principles of CAD/CAM/CAE Systems. Addison Vesley Longman, Inc.
Course Outcomes	At the end of the course, learners will be able **CO1**: **Proficiency in CAD Tools:** Graduates will demonstrate proficiency in utilizing CAD tools, including draw and dimension tool bars, OSNAP, line thickness, and format tool bars,ensuring their ability to create precise and well-documented technical drawings. **CO2: Effective Editing Skills:** Students will exhibit effective editing skills in CAD, showcasing their ability to use mirror, offset, array, trim, extend, chamfer, fillet, copy, move, scale, and rotate commands with precision, allowing for efficient modification of drawings. **CO3: Competence in 2D and 3D Drawing:** Graduates will showcase competence in 2D drawing, including the creation of machine parts with accurate dimensions and allowances, as well as proficiency in 3D drawing techniques such as extrusion, loft, sweep, press pull, revolving, and joining. **CO4: Application of Advanced Commands:** Students will apply advanced commands like creating boundaries, regions, hatches, gradients, and editing polylines using PEDIT and Explode commands, demonstrating their ability to handle complex drawing tasks in CAD. **CO5: Understanding of CNC Machining:** Graduates will gain a foundational understanding of CNC machines and their applications, allowing them to comprehend modern manufacturing processes and the integration of CAD in CNC machining, preparing them for advanced roles in the field of computer-aided design and manufacturing.
Mapping between Cos, POs and PSOs	

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1															
CO2															
CO3															
CO4															
CO5															

Course Code	**EE-2.4.3**
Course Title	**Applied Electronics and Instrumentation**
Course Credit	**3 (2+1)**
Objectives of Course	1. To understand the mechanisms of current flow in semi-conductors. 2. To familiarize on the principle of operation, capabilities and limitation of various advanced semiconductor devices and its practical application. 3. To provide information on the basics of Electronic Measurements. 4. To include specialized information needed for Analog and Digital Instrumentation. 5. To exploit an instrument's potential, to be aware of its limitations.
Course Content	**Theory:** Semiconductors. p—n junction. V—I characteristics of p—n junction. diode as a circuit element. rectifier. clipper. damper, voltage multiplier, capacitive filter. diode circuits for OR & AND (both positive and negative logic), bipolar junction transistor: operating point. Classification (A.B & C) of amplifier. various biasing methods (fixed. self-potential divider). h-parameter model of a transistor. analysis of small signal. CE amplifier. phase shift oscillator, analysis of differential amplifier using transistor. Ideal OP-AMP characteristics. linear and non-linear applications of OP-AMP (adder. subtractor. integrator, active rectifier. comparator. differentiator. differential, instrumentation amplifier and oscillator). zener diode voltage regulator. transistor series regulator. current limiting. OP-AMP voltage regulators. Basic theorem of Boolean algebra. Combinational logic circuits (basic gates. SOP rule and Kmap). Binary ladder D/A converter, successive approximation A/D converter, generalized instrumentation, measurement of displacement. temperature. velocity, force and pressure using potentiometer. resistance thennometer. thermocouples. Bourclen tube. LVDT. strain gauge and tacho-generator. **Practicals:** To study V-I characteristics of p-n junction diode: To study half wave. full wave and bridge rectifier: To study transistor characteristics in CE configurations: To design and study fixed and self-bias transistor: To design and study potential divider bias transistor: To study a diode as clipper and clamper: To study a OP- AMP IC 741 as inverting and non- inverting amplifier: To study a OP-AMP IC 741 as differentiator and integrator to study a differential amplifier using two transistor: To study a OP-AMP IC 741 as differential amplifier: To study a zener regulator circuit: To study a OP-AMP IC 741 as a active rectifier: To study a OP-AMP IC 741 as a comparator: To familiarize with various types of transducers.
References	1. Robert L Boyelsted, Electronic Devices and Circuit Theory 2. Mehta V K. Principles of Electronics. S. Chand and Co., New Delhi. 3. Shaney A K. Measurement of Electronics and Electronic Instrumentation. Khanna Publications. Roy Chowdary. Integrated Electronics. John Wiley International.

	4. Kumar Anand. Digital Electronics. A. PHI. 5. Gupta Sanjeev, Sonthosh Gupta. Electronic Devices and Circuits. Danapath Rai Publications
Course Outcomes	At the end of the course, learners will be able. **CO1:** Demonstrate the flow of charge carriers in semiconductor and interpret the VI relations. **CO2:** Understand the physical and functional properties of diode. **CO3:** Compare the properties of different configurations of bipolar junction transistors. **CO4:** Correctly interpret the measurement results. **CO5:** Suggest the instrument suitable for a specific application

Mapping between Cos, POs and PSOs

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1															
CO2															
CO3															
CO4															
CO5															

Course Code	**FMPE-2.4.4**
Course Title	**Tractor and Automotive Engines**
Course Credit	**3 (2 + 1)**
Objectives of Course	1)To get the knowledge about the sources of power available on the farm. 2) To acquaintance with IC engine, its principle & laws, components and working. 3)To get technical knowledge about different systems of IC engine. 4) To get familiar about basics of engine testing.
Course Content	**Course Content: Theory** Study of sources of farm power –conventional & non-conventional energy sources. Classification of tractors and IC engines. Review of thermodynamic principles of IC (CI & SI) engines and deviation from ideal cycle. General energy equation and heat balance sheet. Study of mechanical, thermal and volumetric efficiencies. Study of engine components their construction, operating principles and functions. Study of engine strokes and comparison of 2-stroke and 4-stroke engine cycles and CI and SI engines. Study of Engine Valve systems, valve mechanism, Valve timing diagram, and valve clearance adjustment Study of Cam profile, valve lift and valve opening area. Study of importance of air cleaning system. Study of types of air cleaners and performance characteristics of various air cleaners. Study of fuel supply system. Study of fuels, properties of fuels, calculation of air-fuel ratio. Study of tests on fuel for SI and CI engines. Study of detonation and knocking in IC engines. Study of carburetion system, carburetors and their main functional components. Study of fuel injection system – Injection pump, their types, working principles. Fuel injector nozzles – their types and working principle. Engine governing – need of governors, governor types and governor characteristics. Study of lubrication system – need, types, functional components. Study of lubricants – physical properties, additives and their application. Engine cooling system – need, cooling methods and main functional components. Study of need and type of thermostat valves. Additives in the coolant. Study of radiator efficiency. Study of ignition system of SI engines. Study of electrical system including battery, starting motor, battery charging, cut-out, etc. Comparison of dynamo and alternator. Familiarization with the basics of engine testing. **Practical**

	Introduction to different systems of CI engines; Engine parts and functions, working principles etcValve system – study, construction and adjustments; Oil & Fuel– determination of physical properties; Air cleaning system; Fuel supply system of SI engine; Diesel injection system & timing; Cooling system, and fan performance, thermostat and radiator performance evaluation; Part load efficiencies & governing; Lubricating system & adjustments; Starting and electrical system; Ignition system; Tractor engine heat balance and engine performance curves; Visit to engine manufacturer/ assembler/ spare parts agency.
References	• Liljedahl J B and Others. Tractors and Their Power Units. • Rodichev V and G Rodicheva. Tractors and Automobiles. • Mathur ML and RP Sharma. A course in Internal Combustion Engines. • Singh Kirpal. Automobile Engineering – Vol II. • Heitner Joseph. Automotive Mechanics : Principles and Practices.
Course Outcomes	At the end of the course, learners will be able **CO1**: Able to select and use of proper farm source for doing various farm operations. **CO2**: Get in depth knowledge about IC engine components and it's working. **CO3**: Become technically sound about working of different systems of IC engine. **CO4**: Become familiar about basics of engine testing.

Mapping between Cos, POs and PSOs

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1															
CO2															
CO3															
CO4															

Course Code	PFE – 2.4.5
Course Title	Engineering Properties of Agricultural Produce
Course Credit	2 (1 + 1)
Objectives of Course	1. To enable the students to understand the principles and concepts of various properties of agricultural produces 2. To understand the physical laws governing the response of the agricultural produces to various physical treatments so that the machines, processes and handling operations can be designed for maximum efficiency and the highest quality of the end products.
Course Content	Classification and importance of engineering properties of Agricultural Produce, shape, size, roundness, sphericity, volume, density, porosity, specific gravity, surface area of grains, fruits and vegetables, Thermal properties, Heat capacity, Specific heat, Thermal conductivity, Thermal diffusivity, Heat of respiration; Coefficient of thermal expansion, Friction in agricultural materials; Static friction, Kinetic friction, rolling resistance, angle of internal friction, angle of repose, Flow of bulk granular materials, Aero dynamics of agricultural products, drag coefficients, terminal velocity. Rheological properties; force, deformation, stress, strain, elastic, plastic and viscous behaviour, Newtonian and Non-Newtonian liquid, Visco-elasticity, Newtonian and Non-Newtonian fluid, Pseudo-plastic, Dilatant, Thixotropic, Rheopectic and Bingham Plastic Foods, Flow curves. Electrical properties; dielectric loss factor, loss tangent, A.C. conductivity and dielectric constant, method of determination. Application of engineering properties in handling processing machines and storage structure.
References	• Mohesin, N.N. 1980. Physical Properties of Plants & Animals. Gordon & Breach Science Publishers , New York. Mohesin,

	• N.N. 1980. Thermal Properties of Foods and Agricultural Materials. Gordon & Breach Science Publishers , New York. • Prentice, J.H. 1984. Measurement in Rheological Properties of Food Stuffs. Elsevier Applied science Pub. Co. Inc. New York. • Rao, M.A. and Rizvi, S.H., 1995. Engineering Properties of Foods. Marcel Dekker Inc. New York. • Singhal OP & Samuel DVK. 2003. Engineering Properties of Biological Materials. Saroj Prakashan.
Course Outcomes	At the end of the course, learners will be able **CO1**: Demonstrate knowledge of various engineering methods to measure engineering properties like physical, thermal, rheological properties and quality control in agricultural produces. **CO2**: Knowledge of methods to determine various engineering properties of agricultural produces and its physical, thermal and rheological properties. CO3: Identify, choose and implement appropriate techniques for prediction of various engineering properties.

Mapping between Cos, POs and PSOs

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1															
CO2															
CO3															

Course Code	**SWCE-2.4.6**
Course Title	**Watershed Hydrology**
Course Credit	**1 (1 + 1)**
Objectives of Course	• Comprehend the hydrologic cycle, including precipitation forms, rainfall measurement techniques, and frequency analysis for point rainfall, focusing on mean rainfall estimation. • Analyze hydrological processes like interception, infiltration, and evaporation, exploring influencing factors, measurement methods, and estimation indices. • Evaluate runoff factors, measurement techniques, and methodologies such as Rational method, Cook's method, and SCS curve number method for estimating peak runoff rate and volume. • Investigate watershed geomorphology, encompassing linear, aerial, and relief aspects, along with stream order, drainage density, and stream frequency analysis. • Understand hydrograph components, base flow separation, unit hydrograph theory, synthetic hydrograph, flood estimation techniques, and flood routing methods, including channel and reservoir routing, considering their applications and limitations.
Course Content	Theory: Hydrologic cycle, precipitation and its forms, rainfall measurement and estimation of mean rainfall, frequency analysis of point rainfall. Mass curve, hyetograph, depth-area-duration curves and intensity-durationfrequency relationship. Hydrologic processes-Interception, infiltration -factors influencing, measurement and indices. Evaporation - Estimation and measurement. Runoff - Factors affecting, measurement, stage - discharge rating curve, estimation of peak runoff rate and volume, Rational method, Cook's method and SCS curve number method. Geomorphology of watersheds – Linear, aerial and relief aspects of watersheds- stream order, drainage density and stream frequency. Hydrograph - Components,base flow separation, unit hydrograph theory, S-curve, synthetic hydrograph, applications and limitations. Stream gauging - discharge rating

	curves, flood peak, design flood and computation of probable flood. Flood routing – channel and reservoir routing. Drought – classification, causes and impacts, drought management strategy. Practical: Visit to meteorological observatory and study of different instruments. Design of rain gauge network. Exercise on intensity - frequency - duration curves. Exercise on depth - area - duration and double mass curves. Analysis of rainfall data and estimation of mean rainfall by different methods. Exercise on frequency analysis of hydrologic data and estimation of missing data, test for consistency of rainfall records. Exercise on computation of infiltration indices. Computation of peak runoff and runoff volume by Cook's method and rational formula. Computation of runoff volume by SCS curve number method. Study of stream gauging instruments - current meter and stage level recorder. Exercise on geomorphic parameters of watersheds. Exercise on runoff hydrograph. Exercise on unit hydrograph. Exercise on synthetic hydrograph. Exercise on flood routing.
References	• Chow, V.T., D.R. Maidment and L.W. Mays. 2010. Applied Hydrology, McGraw Hill Publishing Co., New York. • Jaya Rami Reddy, P. 2011. A Text Book of Hydrology. University Science Press, New Delhi. • Linsley, R.K., M.A. Kohler, and J.L.H. Paulhus. 1984. Hydrology for Engineers. McGraw-Hill Publishing Co., Japan. • Mutreja, K.N. 1990. Applied Hydrology. Tata McGraw-Hill Publishing Co., New Delhi. • Raghunath, H.M. 2006. Hydrology: Principles Analysis and Design. Revised 2nd Edition, New Age International (P) Limited Publishers, New Delhi. • Subramanya, K. 2008. Engineering Hydrology. 3rd Edition, Tata McGraw-Hill Publishing Co., New Delhi. • Suresh, R. 2005. Watershed Hydrology. Standard Publishers Distributors, Delhi. Varshney, R.S. 1986. Engineering Hydrology. Nem Chand and Brothers, Roorkee, U.P.
Course Outcomes	At the end of the course, learners will be able CO1: Demonstrate a profound understanding of the hydrologic cycle, precipitation forms, rainfall measurement techniques, and frequency analysis, focusing on mean rainfall estimation and its significance in hydrological studies. CO2: Apply knowledge of mass curves, hyetographs, depth-area-duration curves, and intensity-duration-frequency relationships, emphasizing their role in characterizing rainfall patterns and their influence on hydrologic processes. CO3: Analyze hydrologic processes such as interception, infiltration, and evaporation, exploring the factors that influence them, their measurement methods, and the indices used to assess their impact on water resources. CO4: Evaluate runoff factors affecting peak runoff rate and volume, utilizing methodologies like the Rational method, Cook's method, and SCS curve number method, along with stage-discharge rating curves, to estimate and manage runoff effectively. CO5: Assess watershed geomorphology, including linear, aerial, and relief aspects, stream order, drainage density, and stream frequency, and demonstrate an understanding of hydrograph components, base flow separation, unit hydrograph theory, flood estimation techniques, flood routing methods, and drought classification and management strategies.
Mapping between COs with POs and PSOs **Please refer mapping of PO and PSO for the style of mapping.**	
Mapping between Cos, POs and PSOs	

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1															
CO2															
CO3															
CO4															
CO5															

Course Code	**IDE-2.4.7**
Course Title	**Irrigation Engineering**
Course Credit	**3(2+1)**
Objectives of Course	1. Design and implement efficient irrigation systems that utilize mathematical and scientific principles to optimize water delivery and crop yield. 2. Analyse the environmental impact of irrigation projects and develop sustainable practices that minimize water waste and protect natural resources. 3. Effectively communicate the importance of efficient irrigation and its impact on agricultural productivity and environmental sustainability to stakeholders. 4. Conduct research on soil-water-plant relationships to optimize irrigation practices and improve crop water use efficiency. 5. Design and manage underground pipe conveyance systems for efficient and reliable water delivery.
Course Content	**Theory:** Major and medium irrigation schemes of India, purpose of irrigation, environmental impact of irrigation projects, source of irrigation water, present status of development and utilization of different water resources of the country; measurement of irrigation water: weir, flumes and orifices and other methods; open channel water conveyance system : design and lining of irrigation field channels, on farm structures for water conveyance, control & distribution; underground pipe conveyance system: components and design; land grading: criteria for land levelling, land levelling design methods, estimation of earth work; soil water plant relationship: soil properties influencing irrigation management, soil water movement, infiltration, soil water potential, soil moisture characteristics, soil moisture constants, measurement of soil moisture, moisture stress and plant response; water requirement of crops: concept of evapotranspiration (ET), measurement and estimation of ET, water and irrigation requirement of crops, depth of irrigation, frequency of irrigation, irrigation efficiencies; surface methods of water application: border, check basin and furrow irrigation- adaptability, specification and design considerations. **Practical:** Measurement of soil moisture by different soil moisture measuring instruments; measurement of irrigation water; measurement of infiltration characteristics; determination of bulk density, field capacity and wilting point; estimation of evapotranspiration; land grading methods; design of underground pipeline system; estimation of irrigation efficiency; study of advance, recession and computation of infiltration opportunity time; infiltration by inflow-outflow method; evaluation of border irrigation method; evaluation of furrow irrigation method; evaluation of check basin irrigation method.
References	• Michael A.M. 2012. Irrigation: Theory and Practice. Vikas Publishing House New Delhi. • Majumdar D. K. 2013. Irrigation Water Management Principles. PHI learning Private Limited New Delhi 2nd Edition.

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Allen R. G., L. S. Pereira, D. Raes, M. Smith. 1998. Crop Evapotranspiration guidelines for computing crop water requirement. Irrigation and drainage Paper 56, FAO of United Nations, Rome. Murthy VVN. 2013. Land and Water Management Engineering. Kalyani Publishers, New Delhi.
Israelsen O W. and Hansen V. E and Stringham G. E. 1980. Irrigation Principles and Practice, John Wiley & Sons, Inc. USA.

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<tr><td>Course Outcomes</td><td>At the end of the course, learners will be able
CO1: Apply engineering principles to design and implement efficient irrigation systems that optimize water delivery and crop yield.
CO2: Analyse soil-water-plant relationships to optimize irrigation practices and improve crop water use efficiency.
CO3: Develop and evaluate innovative solutions for water management challenges in agricultural settings, considering environmental and sustainability factors.
CO4: Effectively communicate the importance of efficient irrigation and its impact on stakeholders within the agricultural industry and broader community.
CO5: Demonstrate proficiency in utilizing modern tools and technologies for measurement, data analysis, and design in irrigation engineering projects.</td></tr>
<tr><td colspan="2">Mapping between COs with POs and PSOs</td></tr>
<tr><td colspan="2">Mapping between Cos, POs and PSOs
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<tr><th rowspan="2">CO</th><th colspan="12">PO</th><th colspan="3">PSO</th></tr>
<tr><th>1</th><th>2</th><th>3</th><th>4</th><th>5</th><th>6</th><th>7</th><th>8</th><th>9</th><th>10</th><th>11</th><th>12</th><th>1</th><th>2</th><th>3</th></tr>
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CO = Course outcome with PSO = Program Specific outcome PO1

Marks System

1 – Slightly Related, 2 – Moderately Related, 3 – Substantial Related, Leave Blank for non-related</td></tr>
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Course Code	**IDE-2.4.8**
Course Title	**Sprinkler and Micro irrigation Systems**
Course Credit	**2(1+1)**
Objectives of Course	1. Understand the principles and applications of sprinkler and micro irrigation systems. 2. Design and install sprinkler and micro irrigation systems for various crops and soil conditions. 3. Evaluate the performance and efficiency of sprinkler and micro irrigation systems. 4. Implement fertigation techniques for efficient fertilizer application. 5. Analyze the economic feasibility of sprinkler and micro irrigation systems.
Course Content	**Theory:** Sprinkler irrigation: adaptability, problems and prospects, types of sprinkler irrigation systems; design of sprinkler irrigation system: layout selection, hydraulic design of lateral, sub-main and main pipe line, design steps; selection of pump and power unit for sprinkler irrigation system; performance evaluation of sprinkler irrigation system: uniformity coefficient and pattern efficiency; Micro Irrigation Systems: types-drip, spray, & bubbler systems, merits and demerits, different components; Design of drip irrigation system: general considerations, wetting patters, irrigation requirement, emitter selection, hydraulics of drip irrigation system, design steps; necessary steps for proper operation of a drip irrigation system; maintenance of micro irrigation system: clogging problems, filter cleaning, flushing and chemical treatment; fertigation: advantages and limitations of fertigation, fertilizers solubility and their compatibility, precautions for successful fertigation system, fertigation frequency, duration and injection rate, methods of fertigation. **Practical:** Study of different components of sprinkler irrigation system; design and installation of sprinkler irrigation system; determination of precipitation pattern, discharge and uniformity coefficient; cost economics of sprinkler irrigation system; study of different components of drip irrigation; design and installation of drip irrigation system; determination of pressure discharge relationship and emission uniformity for given emitter; study of different types of filters and determination of filtration efficiency; determination of rate of injection and calibration for chemigation/fertigation; design of irrigation and fertigation schedule for crops; field visit to micro irrigation system and evaluation of drip system; cost economics of drip irrigation system.
References	• Keller Jack and Bliesner Ron D. 2001. Sprinkle and Trickle Irrigation. Springer Science+ business Media, New York . • Mane M.S. and Ayare B.L.2007. Principles of Sprinkler Irrigation systems, Jain Brothers, New Delhi. Mane M.S and Ayare B.L. and MagarS.S.2006.Principles of Drip Irrigation systems, Jain Brothers, New Delhi. • Michael AM, Shrimohan and KR Swaminathan. Design and evaluation of irrigation methods, (IARI Monograph No.1). Water Technology Centre, IARI New Delhi. • Michael A.M. 2012. Irrigation: Theory and Practice. Vikas Publishing Vikas Pub. House New Delhi. Choudhary M.L and Kadam U.S 2006. Micro irrigation for cash crops Westville Publishing
Course Outcomes	At the end of the course, learners will be able **CO1:** Explain the types, components, and applications of sprinkler and micro irrigation systems.

	CO2: Design and layout sprinkler and micro irrigation systems considering crop water requirements and soil characteristics. **CO3:** Evaluate the performance of sprinkler and micro irrigation systems using relevant metrics like uniformity coefficient and pattern efficiency. **CO4:** Implement and manage fertigation systems for efficient nutrient delivery to crops. **CO5:** Analyse the economic viability of sprinkler and micro irrigation systems considering initial investment, operational costs, and potential benefits.

Mapping between Cos, POs and PSOs

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	1	2	1	1	1	1	1	2	2	1	1	3	3	2
CO2	3	1	3	1	2	1	1	1	2	2	2	2	3	3	3
CO3	2	3	2	2	1	1	1	1	2	1	2	2	3	2	2
CO4	3	2	3	2	1	2	2	1	2	2	2	2	3	3	3
CO5	3	1	3	1	2	1	1	1	2	1	3	3	3	3	3

Course Code	**REE -2.4.9**
Course Title	**Fundamentals of Renewable Energy Sources**
Course Credit	**3 (2+1)**
Objectives of Course	1. To understand the various forms of conventional energy resources. 2. To learn the present energy scenario and the need for energy conservation. 3. To explain the concept of various forms of renewable energy. 4. To outline division aspects and utilization of renewable energy sources for both domestics and industrial application. 5. Analyse the environmental aspects of renewable energy sources.
Course Content	**Theory:** Concept and limitation of Renewable Energy Sources (RES), Criteria for assessing the potential of RES, Classification of RES, Solar, Wind, Geothermal, Biomass, Ocean energy sources, Comparison of renewable energy sources with non renewable sources. Solar Energy: Energy available from Sun, Solar radiation data, solar energy conversion into heat through, Flat plate and Concentrating collectors, different solar thermal devices, Principle of natural and forced convection drying system, Solar Photo voltaics: p-n junctions. Solar cells, PV systems, Stand alone, Grid connected solar power station, Calculation of energy through photovoltaic power generation and cost economics. Wind Energy: Energy available from wind, General formula, Lift and drag. Basis of Wind energy conversion, Effect of density, Frequency variances, Angle of attack, Wind speed, Types of Windmill rotors, Determination of torque coefficient, Induction type generators, Working principle of wind power plant. Bio-energy: Pyrolysis of Biomass to produce solid, liquid and gaseous fuels. Biomass gasification, Types of gasifier, various types of biomass cook stoves for rural energy needs. Biogas: types of biogas plants, biogas generation, factors affecting biogas generation and usages, design consideration, advantages and disadvantages of biogas spent slurry. **Practicals:** Study of different types of solar cookers, solar water heating system, natural convection solar dryer, forced convection solar dryer, solar desalination unit, solar greenhouse for agriculture production, biogas plants, biomass gasifiers, biomass improved cook-stoves, solar photovoltaic system.
References	1. Rai, G.D. 2013. Non-Conventional Energy Sources, Khanna Publishers, Delhi. 2. Rai, G.D., Solar Energy Utilization, Khanna Publishers, Delhi.

3. Khandelwal, K.C. & S. S. Mahdi. 1990. Biogas Technology- A Practical Handbook.
4. Rathore N. S., Kurchania A. K., Panwar N. L. 2007. Non Conventional Energy Sources, Himanshu Publications.
5. Tiwari, G.N. and Ghoshal, M.K. 2005. Renewable Energy Resources: Basic Principles and Applications. Narosa Pub. House. Delhi.
6. Rathore N. S., Kurchania A. K., Panwar N. L. 2007. Renewable Energy, Theory and Practice, Himanshu Publications.
7. Reed TB and Das A. Handbook of Biomass Downdraft Gasifier Engine System.
8. The Biomass Energy Foundation Press, Colorado; 1984.

Course Outcomes

At the end of the course, learners will be able

CO1: Describe the environmental aspects of non-conventional energy resources. In Comparison with various conventional energy systems, their prospects and limitations.

CO2: Know the need of renewable energy resources, historical and latest developments. Describe the use of solar energy and the various components used in the energy production with respect to applications like - heating, cooling, desalination, power generation, drying, cooking etc.

CO3: Appreciate the need of Wind Energy and the various components used in energy generation and know the classifications.

CO4: Understand the concept of Biomass energy resources and their classification, types of biogas Plants- applications

CO5: Compare Solar, Wind and bio energy systems, their prospects, Advantages and limitations.Acquire the knowledge of fuel cells, wave power, tidal power and geothermal principles and applications.

Mapping between Cos, POs and PSOs

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1															
CO2															
CO3															
CO4															
CO5															

Course Code	**FMPE-3.5.1**
Course Title	**Farm Machinery and Equipment-I**
Course Credit	**3 (2 + 1)**
Objectives of Course	1) To understand the concept of farm mechanization, status, scope and its utility. 2) To get the knowledge about tillage, types of tillage and equipments used for it. 3) To get the knowledge about sowing and planting machineries, its components, adjustments and calibration. 4) To acquaintance with calculations of cost of operation of various agricultural machineries 5) To familiarise about the material of construction used for development of components of agricultural machineries.
Course Content	**Theory** Introduction to farm mechanization. Classification of farm machines. Unit operations in crop production. Identification and selection of machines for various operations on the farm. Hitching systems and controls of farm machinery. Calculation of field capacities and field efficiency. Calculations for economics of machinery usage, comparison of ownership with hiring of machines. Introduction to seed-bed preparation and its classification.

	Familiarization with land reclamation and earth moving equipment. Introduction to machines used for primary tillage, secondary tillage, rotary tillage, deep tillage and minimum tillage. Measurement of draft of tillage tools and calculations for power requirement for the tillage machines. Introduction to tillage machines like mould-board plough, disc plough, chisel plough, sub-soiler, harrows, cultivators, Identification of major functional components. Attachments with tillage machinery. Introduction to sowing, planting & transplanting equipment. Introduction to seed drills, no-till drills, and strip-till drills.Introduction to planters, bed-planters and other planting equipment. Study of types of furrow openers and metering systems in drills and planters. Calibration of seed-drills/ planters. Adjustments during operation. Introduction to materials used in construction of farm machines. Heat treatment processes and their requirement in farm machines. Properties of materials used for critical and functional components of agricultural machines. Introduction to steels and alloys for agricultural application. Identification of heat treatment processes specially for the agricultural machinery components. **Practical** Familiarization with different farm implements and tools. Study of hitching systems, Problems on machinery management. Study of primary and secondary tillage machinery – construction, operation, adjustments and calculations of power and draft requirements. Study of sowing and planting equipment – construction, types, calculation for calibration and adjustments. Study of transplanters – paddy, vegetable, etc. Identification of materials of construction in agricultural machinery and study of material properties. Study of heat treatment processes subjected to critical components of agricultural machinery.
References	• Kepner RA, Roy Barger & EL Barger. Principles of Farm Machinery. • Smith HP and LH Wilkey. Farm Machinery and Equipment. • Culpin Claude. Farm Machinery. • Srivastava AC. Elements of Farm Machinery. • Lal Radhey and AC Datta. Agricultural Engineering.
Course Outcomes	At the end of the course, learners will be able **CO1**:Know about status and scope farm mechanization in India. **CO2**:Understand the concept of tillage and equipments used for it. **CO3**:Understand the working/calibration/ adjustments of sowing and planting machineries. **CO4**:Able to calculate of cost of operation of various agricultural machineries **CO5**:Able to select the proper material development of components of agricultural machineries.

Mapping between Cos, POs and PSOs

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1															
CO2															
CO3															
CO4															
CO5															

Course Code	**FMPE-3.5.2**
Course Title	**Tractor Systems and Controls**
Course Credit	**3 (2 + 1)**
Objectives of Course	1) To get knowledge about different systems of tractor- its need, types, functional requirements, construction and principle of operation. 2) To acquaintance with tractor mechanics 3) To understand the concept of traction and weight transfer phenomenon of tractor. 4) To understand use of ergonomic considerations and operational safety in tractor design. 5) To familiarise about tractor testing and its respective codes.
Course Content	**Theory** Study of need for transmission system in a tractor. Transmission system – types, major functional systems. Study of clutch – need, types, functional requirements, construction and principle of operation. Familiarization with single plate, multi-plate, centrifugal and dual clutch systems. Study of Gear Box – Gearing theory, principle of operation, gear box types, functional requirements, and calculation for speed ratio. Study of differential system – need, functional components, construction, calculation for speed reduction. Study of need for a final drive. Study of Brake system – types, principle of operation, construction, calculation for braking torque. Study of steering system – requirements, steering geometry characteristics, functional components, calculation for turning radius. Familiarization with Ackerman steering. Steering systems in track type tractors. Study of Hydraulic system in a tractor – Principle of operation, types, main functional components, functional requirements. Familiarization with the Hydraulic system adjustments and ADDC. Study of tractor power outlets – PTO. PTO standards, types and functional requirements. Introduction to traction. Traction terminology. Theoretical calculation of shear force and rolling resistance on traction device. Study of wheels and tyres – Solid tyres and pneumatic tyres, tyre construction and tyre specifications. Study of traction aids. Study of tractor mechanics – forces acting on the tractor. Determination of CG of a tractor. Determination and importance of moment of inertia of a tractor. Study of tractor static equilibrium, tractor stability especially at turns. Determination of maximum drawbar pull. Familiarization with tractor as a spring-mass system. Ergonomic considerations and operational safety. Introduction to tractor testing. Deciphering the engine test codes. **Practical** Introduction to transmission systems and components; Study of clutch functioning, parts and design problem on clutch system; Study of different types of gear box, calculation of speed ratios, design problems on gear box; Study on differential and final drive and planetary gears; Study of brake systems and some design problems; Steering geometry and adjustments; Study of hydraulic systems in a tractor, hydraulic trainer and some design problems; Appraisal of various controls in different makes tractors in relation to anthropometric measurements. Determination of location of CG of a tractor, Moment of Inertia of a tractor. Traction performance of a traction wheel.
References	• Liljedahl J B and Others. Tractors and Their Power Units. • Rodichev V and G Rodicheva. Tractors and Automobiles. • Singh Kirpal. Automobile Engineering – Vol I. • Heitner Joseph. Automotive Mechanics: Principles and Practices. • C.B.Richey. Agricultural Engineering Handbook. • John Deere. Fundamentals of Service Hydraulics. • Relevant BIS Test Codes for Tractors.

Course Outcomes	At the end of the course, learners will be able **CO1**: Able to identify and repair trouble shooting coming during operation of the tractor **CO2**: Design different systems of tractor **CO3**: Able to develop different components of the tractor system. **CO4**:Able to design comfortable and less hazardous work station for tractor. **CO5**: Become familiar with tractor testing and its respective codes.

Mapping between Cos, POs and PSOs

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1															
CO2															
CO3															
CO4															
CO5															

Course Code	PFE – 3.5.3
Course Title	**Agricultural Structures and Environment Control**
Course Credit	3 (2 + 1)
Objectives of Course	1. To impart knowledge on need of environmental control, environmental control systems, farm structures, etc. 2. To impart knowledge on storage of grain, traditional and modern storage structures, rural water supply, sewage system etc. 3. To enable the students to acquire skills and to understand farm structures, design grain storage, etc, and rural development activities
Course Content	Planning and layout of farmstead. Scope, importance and need for environmental control, physiological reaction of livestock environmental factors, environmental control systems and their design, control of temperature, humidity and other air constituents by ventilation and other methods, Livestock production facilities, BIS Standards for dairy, piggery, poultry and other farm structures. Design, construction and cost estimation of farm structures; animal shelters, compost pit, fodder silo, fencing and implement sheds, barn for cows, buffalo, poultry, etc. Storage of grains, Causes of spoilage, Water activity for low and high moisture food and its limits for storage, Moisture and temperature changes in grain bins; Traditional storage structures and their improvements, Improved storage structures (CAP, hermetic storage, Pusa bin, RCC ring bins), Design consideration for grain storage godowns, Bag storage structures, Shallow and Deep bin, Calculation of pressure in bins, Storage of seeds. Rural living and development, rural roads, their construction cost and repair and maintenance. Sources of water supply, norms of water supply for human being and animals, drinking water standards and water treatment suitable to rural community. Site and orientation of building in regard to sanitation, community sanitation system; sewage system and its design, cost and maintenance, design of septic tank for small family. Estimation of domestic power requirement, source of power supply and electrification of rural housing.
References	• Pandey, P.H. Principles and practices of Agricultural Structures and Environmental Control, Kalyani Publishers, Ludhiana. • Ojha, T.P and Michael, A.M. Principles of Agricultural Engineering, Vol. I, Jain Brothers, Karol Bag, New Delhi. • Nathonson, J.A. Basic Environmental Technology, Prentice Hall of India, New Delhi. • Venugopal Rao, P. Text Book of Environmental Engineering, Prentice Hall of India, New Delhi. • Garg, S.K. Water Supply Engineering, Khanna Publishers, New Delhi-6.

	• Dutta, B.N. Estimating and Costing in Civil Engineering, Duttta & CO, Lucknow. • Khanna, P.N. Indian Practical Civil Engineer's Hand Book, Engineer's Publishers, New Delhi. Sahay, K.M. and Singh, K.K. Unit Operations of Agricultural Processing, Vikas publishing pvt. Ltd, Noida. • Banerjee, G.C. A Text Book of Animal Husbandry, Oxford IBH Publishing Co, New Delhi
Course Outcomes	At the end of the course, learners will be able **CO1**: To acquaint the students with various aspects of agricultural structures such as farm stead and dairy barn. **CO2:** To acquaint the students with various aspects of environmental control, renewable and non-renewable resources of energy CO3: Graps the ramifications of the agricultural structural solution within around and awareness for sustainable development CO4: Design solutions for engineering aspects of agricultural structures and environmental part to fulfil the requirements, giving due regards to public health and safety and environmental factors.

Mapping between Cos, POs and PSOs

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1															
CO2															
CO3															
CO4															

Course Code	PFE-3.5.4
Course Title	Post Harvest Engineering of Cereals, Pulses and Oil Seeds
Course Credit	3 (2 + 1)
Objectives of Course	1. To understand the performance evaluation of different types of cleaners and separators, size reduction machines. 2. To understand the laws of size reduction, theory of mixing and milling of cereals, pulses and oilseeds. 3. Study of different types of conveying and elevating equipments, various types of dryers and different equipments in oil mills.
Course Content	Cleaning and grading, aspiration, scalping; size separators, screens, sieve analysis, capacity and effectiveness of screens. Various types of separators: specific gravity, magnetic, disc, spiral, pneumatic, inclined draper, velvet roll, colour sorters, cyclone, shape graders. Size reduction: principle, Bond's law, Kick's law, Rittinger's law, procedure (crushing, impact, cutting and shearing),Size reduction machinery: Jaw crusher, Hammer mill, Plate mill, Ball mill. Material handling equipment. Types of conveyors: Belt, roller, chain and screw. Elevators: bucket, Cranes & hoists. Trucks (refrigerated/ unrefrigerated), Pneumatic conveying. Drying: moisture content and water activity; Free, bound and equilibrium moisture content, isotherm, hysteresis effect, EMC determination, Psychrometric chart and its use in drying, Drying principles and theory, Thin layer and deep bed drying analysis, Falling rate and constant rate drying periods, maximum and decreasing drying rate period, drying equations, Mass and energy balance, Shedd's equation, Dryer performance, Different methods of drying, batch-continuous; mixing-non-mixing, Sunmechanical, conduction, convection, radiation, superheated steam, tempering during drying, Different types of grain dryers: bin, flat bed, LSU, columnar, RPEC, fluidized, rotary and tray. Mixing: Theory of mixing of solids and pastes, Mixing index, types of mixers for solids, liquid foods and pastes. Milling of rice: Conditioning and parboiling, advantages and disadvantages, traditional methods, CFTRI and Jadavpur methods, Pressure parboiling method, Types of rice mills, Modern rice milling, different unit operations and equipment.

	Milling of wheat, unit operations and equipment. Milling of pulses: traditional milling methods, commercial methods, pre-conditioning, dry milling and wet milling methods: CFTRI and Pantnagar methods. Pulse milling machines, Milling of corn and its products. Dry and wet milling. Milling of oilseeds: mechanical expression, screw press, hydraulic press, solvent extraction methods, preconditioning of oilseeds, refining of oil, stabilization of rice bran., Extrusion cooking: principle, factors affecting, single and twin screw extruders. By-products utilization.
References	• Chakraverty, A. Post-Harvest Technology of cereals, pulses and oilseeds. Oxford & IBH publishing Co. Ltd., New Delhi. • Dash, S.K., Bebartta, J.P. and Kar, A. Rice Processing and Allied Operations. Kalyani Publishers, New Delhi. • Sahay, K.M. and Singh, K.K. 1994. Unit operations of Agricultural Processing. Vikas Publishing house Pvt. Ltd. New Delhi. • Geankoplis C. J. Transport processes and unit operations, Prentice Hall of India Pvt Ltd, New Delhi R.L. 2003. Unit Operations in Food Processing. Pergamon Press. Oxford. U.K. • Henderson, S.M., and Perry, R. L. Agricultural Process Engineering, Chapman and hall, London McCabe, W.L., Smith J.C. and Harriott, P. Unit operations of Chemical Engineering. McGraw Hill. • Singh, R. Paul. and Heldman, R.Dennis. 2004. Introduction to Food Engineering. 3rd Edition. Academic Press, London. • Brooker, D.B., Bakker-Arkema,F.W., Hall, C.W. 1992. Drying and storage of grains and oilseeds, AVI publication
Course Outcomes	At the end of the course, learners will be able **CO1:** Construct the flow chart and layout of a food processing. **CO2:** Explain the basic unit operation of food processing in handling and processing equipment. **CO3:** Explain the hammer mill, attrition mill, mixers, mixing index of a feed mixer, fineness modulus and average particle size and power requirement in different types of conveyors. **CO4:** Determine the efficiency of cyclone separator, pneumatic separator, indented cylinder and screen pre cleaner. **CO5:** Identify various methods for determining moisture content using different drying techniques.

Mapping between Cos, POs and PSOs

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1															
CO2															
CO3															
CO4															
CO5															

Course Code	**SWCE-3.5.5**
Course Title	**Soil and Water Conservation Engineering**
Course Credit	**2 (2 + 1)**
Objectives of Course	• Understand the various types and causes of soil erosion, distinguishing between geological and accelerated erosion, while identifying erosion agents, factors influencing erosion, and their consequential effects. • Explore the mechanics and diverse forms of water erosion, such as splash, sheet, rill, gully, ravine, and stream bank erosion, along with the classification and stages of gully development.

	• Apply the Universal Soil Loss Equation (USLE) and modified USLE for estimating soil loss, while comprehending the methods for estimating rainfall erosivity using KE>25 and EI30 methods, and evaluating soil erodibility based on topography, crop management, and conservation practices. • Demonstrate proficiency in soil erosion measurement techniques, including the setup and functioning of runoff plots and soil samplers, for accurate assessment of erosion rates. • Evaluate and discuss erosion control measures encompassing agronomical practices like contour farming, strip cropping, conservation tillage, mulching, as well as engineering interventions such as bunds, terraces, gully control principles, grassed waterways, wind erosion control measures, and techniques for land capability classification, sedimentation rates, silt monitoring, and storage loss in tanks.
Course Content	**Theory:** Soil erosion - Introduction, causes and types - geological and accelerated erosion, agents, factors affecting and effects of erosion. Water erosion - Mechanics and forms - splash, sheet, rill, gully, ravine and stream bank erosion. Gullies - Classification, stages of development. Soil loss estimation – Universal soil loss equation (USLE) and modified USLE. Rainfall erosivity - estimation by KE>25 and EI30 methods. Soil erodibility - topography, crop management and conservation practice factors. Measurement of soil erosion - Runoff plots, soil samplers. Water erosion control measures - agronomical measures - contour farming, strip cropping, conservation tillage and mulching. Engineering measures– Bunds and terraces. Bunds - contour and graded bunds - design and surplussing arrangements. Terraces - level and graded broad base terraces, bench terraces - planning, design and layout procedure, contour stonewall and trenching. Gully and ravine reclamation - principles of gully control - vegetative measures, temporary structures and diversion drains. Grassed waterways and design. Wind erosion- Factors affecting, mechanics, soil loss estimation and control measures - vegetative, mechanical measures, wind breaks and shelter belts and stabilization of sand dunes.Land capability classification. Rate of sedimentation, silt monitoring and storage loss in tanks.. **Practical:** Study of different types and forms of water erosion. Exercises on computation of rainfall erosivity index. Computation of soil erodibility index in soil loss estimation. Determination of length of slope (LS) and cropping practice (CP) factors for soil loss estimation by USLE and MUSLE. Exercises on soil loss estimation/measuring techniques. Study of rainfall simulator for erosion assessment. Estimation of sediment rate using Coshocton wheel sampler and multi-slot devisor. Determination of sediment concentration through oven dry method. Design and layout of contour bunds. Design and layout of graded bunds. Design and layout of broad base terraces. Design and layout of bench terraces. Design of vegetative waterways. Exercises on rate of sedimentation and storage loss in tanks. Computation of soil loss by wind erosion. Design of shelterbelts and wind breaks for wind erosion control. Visit to soil erosion sites and watershed project areas for studying erosion control and water conservation measures.
References	• Singh Gurmel, C. Venkataraman, G. Sastry and B.P. Joshi. 1996. Manual of Soil and Water Conservation Practices. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi. • Mahnot, S.C. 2014. Soil and Water Conservation and Watershed Management. International Books and Periodicals Supply Service, New Delhi.

	• Mal, B.C. 2014. Introduction to Soil and Water Conservation Engineering. 2014. Kalyani Publishers. Michael, A.M. and T.P. Ojha. 2003. Principles of Agricultural Engineering. Volume II. 4th Edition, Jain Brothers, New Delhi. • Murthy, V.V.N. 2002. Land and Water Management Engineering. 4th Edition, Kalyani Publishers, New Delhi. • Norman Hudson. 1985. Soil Conservation. Cornell University Press, Ithaka, New York, USA. • Frevert, R.K., G.O. Schwab, T.W. Edminster and K.K. Barnes. 2009. Soil and Water Conservation Engineering, 4th Edition, John Wiley and Sons, New York. • Suresh, R. 2014. Soil and Water Conservation Engineering. Standard Publisher Distributors, New Delhi.
Course Outcomes	At the end of the course, learners will be able CO1: Comprehend the fundamental principles of soil erosion, distinguishing between geological and accelerated erosion, and recognize the diverse types, causes, agents, and impacts of erosion on soil quality and landscape. CO2: Demonstrate a comprehensive understanding of water erosion mechanics, including various forms such as splash, sheet, rill, gully, ravine, and stream bank erosion, alongside the classification and developmental stages of gullies. CO3: Apply theoretical and practical knowledge to estimate soil loss utilizing methodologies like the Universal Soil Loss Equation (USLE), modified USLE, KE>25, and EI30 methods, and evaluate soil erodibility concerning topography, crop management, and conservation practices. CO4: Develop proficiency in the measurement techniques of soil erosion, utilizing runoff plots, soil samplers, and other relevant methods for accurate assessment and quantification of erosion rates. CO5: Analyze, evaluate, and propose effective erosion control strategies encompassing both agronomical practices (contour farming, strip cropping, conservation tillage, mulching) and engineering measures (bunds, terraces, gully control principles, grassed waterways, wind erosion control, land capability classification, sedimentation rates, silt monitoring, and storage loss in tanks).

Mapping between Cos, POs and PSOs

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1															
CO2															
CO3															
CO4															
CO5															

Course Code	**SWCE-3.5.6**
Course Title	**Watershed Planning and Management**
Course Credit	**2 (1 + 1)**
Objectives of Course	• Understand the fundamental characteristics of watersheds, including their structure, size, and drainage patterns, while exploring the challenges, opportunities, and key components of watershed development projects. • Analyze the complexities involved in watershed management, encompassing the investigation phase, topographical survey techniques, soil characteristics, vegetative cover assessment, and socio-economic factors that influence effective watershed planning. • Demonstrate knowledge of watershed management concepts, objectives, and factors affecting management decisions, utilizing land capability classes, hydrological data, watershed codification, and prioritization techniques like the sediment yield index for planning purposes.

	• Apply theoretical and practical knowledge in developing water budgeting strategies for watersheds, focusing on rainwater conservation technologies, in-situ and ex-situ storage methods, water harvesting, recycling practices, and dry farming techniques like inter-terrace and inter-bund land management. • Evaluate the integrated approach of watershed management, identifying its various components including agriculture, horticulture, forestry, fishery, and animal husbandry, and assess the influence of cropping systems, land management practices, and cultural strategies on watershed hydrology. Additionally, understand the execution, follow-up practices, maintenance, monitoring, and participatory aspects of watershed management programs, including project proposal formulation and cost-benefit analysis.
Course Content	**Theory:** Watershed - introduction and characteristics. Watershed development - problems and prospects, investigation, topographical survey, soil characteristics, vegetative cover, present land use practices and socio-economic factors. Watershed management - concept, objectives, factors affecting, watershed planning based on land capability classes, hydrologic data for watershed planning, watershed codification, delineation and prioritization of watersheds – sediment yield index. Water budgeting in a watershed. Management measures - rainwater conservation technologies - *in-situ* and *ex-situ* storage, water harvesting and recycling. Dry farming techniques - inter-terrace and inter-bund land management. Integrated watershed management - concept, components, arable lands - agriculture and horticulture, nonarable lands - forestry, fishery and animal husbandry. Effect of cropping systems, land management and cultural practices on watershed hydrology. Watershed programme - execution, follow-up practices, maintenance, monitoring and evaluation. Participatory watershed management - role of watershed associations, user groups and self-help groups. Planning and formulation of project proposal for watershed management programme including cost-benefit analysis.. **Practical:** Exercises on delineation of watersheds using toposheets. Surveying and preparation of watershed map. Quantitative analysis of watershed characteristics and parameters. Watershed investigations for planning and development. Analysis of hydrologic data for planning watershed management. Water budgeting of watersheds. Prioritization of watersheds based on sediment yield index. Study of functional requirement of watershed development structures. Study of watershed management technologies. Practice on softwares for analysis of hydrologic parameters of watershed. Study of role of various functionaries in watershed development programmes. Techno-economic viability analysis of watershed projects. Visit to watershed development project areas.
References	• Ghanshyam Das. 2008. Hydrology and Soil Conservation Engineering: Including Watershed Management. 2nd Edition, Prentice-Hall of India Learning Pvt. Ltd., New Delhi. • Katyal, J.C., R.P. Singh, Shriniwas Sharma, S.K. Das, M.V. Padmanabhan and P.K. Mishra. 1995. Field Manual on Watershed Management. CRIDA, Hyderabad. • Mahnot, S.C. 2014. Soil and Water Conservation and Watershed Management. International Books and Periodicals Supply Service. New Delhi. • Sharda, V.N., A.K. Sikka and G.P. Juyal. 2006. Participatory Integrated Watershed Management: A Field Manual. Central Soil and Water Conservation Research and Training Institute, Dehradun. • Singh, G.D. and T.C. Poonia. 2003. Fundamentals of Watershed Management Technology. Yash Publishing House, Bikaner.

	• Singh, P.K. 2000. Watershed Management: Design and Practices. E-media Publications, Udaipur. • Singh, R.V. 2000. Watershed Planning and Management. Yash Publishing House, Bikaner. • Tideman,E.M. 1999. Watershed Management: Guidelines for Indian Conditions. Omega Scientific Publishers, New Delhi.
Course Outcomes	CO1: Demonstrate comprehension of watershed characteristics, including topography, soil attributes, vegetative cover, and socio-economic factors influencing watershed development, and its implications in investigating watershed problems and prospects. CO2: Apply the principles of watershed management by analyzing hydrological data, conducting watershed delineation, codification, and prioritization using sediment yield index, while integrating water budgeting techniques for effective resource allocation. CO3: Evaluate rainwater conservation technologies such as in-situ and ex-situ storage, water harvesting, and recycling methods, along with dry farming techniques like inter-terrace and inter-bund land management, for sustainable water resource utilization. CO4: Synthesize the components of integrated watershed management, incorporating arable lands for agriculture and horticulture and non-arable lands for forestry, fishery, and animal husbandry, while assessing the impact of land management practices on watershed hydrology. CO5: Formulate comprehensive project proposals for watershed management programs, including cost-benefit analysis, and demonstrate proficiency in executing, monitoring, and evaluating watershed programs through participatory approaches involving watershed associations, user groups, and self-help groups.

Mapping between COs with POs and PSOs

Please refer mapping of PO and PSO for the style of mapping.

Mapping between Cos, POs and PSOs

CO	**PO**												**PSO**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1															
CO2															
CO3															
CO4															
CO5															

Course Code	**IDE-3.5.7**
Course Title	**Drainage Engineering**
Course Credit	**2(1+1)**
Objectives of Course	1. Understand the causes and impacts of waterlogging. 2. Design and implement surface and subsurface drainage systems. 3. Analyze the hydrological and soil parameters relevant to drainage design. 4. Evaluate the performance of drainage systems. 5. Apply appropriate technologies for reclaiming saline and alkaline soils.
Course Content	**Theory:** Water logging- causes and impacts; drainage, objectives of drainage, familiarization with the drainage problems of the state; surface drainage coefficient, types of surface drainage, design of surface drains; sub-surface drainage: purpose and benefits, investigations of design parameters-hydraulic conductivity, drainable porosity, water table; derivation of Hooghoudt's and Ernst's drain spacing equations; design of subsurface drainage system; drainage materials, drainage pipes, drain envelope; layout, construction and installation of drains; drainage structures; vertical drainage; bio-drainage; mole drains; salt

	balance, reclamation of saline and alkaline soils, leaching requirements, conjunctive use of fresh and saline water. **Practical:** In-situ measurement of hydraulic conductivity by single auger hole and inverse auger hole method; Estimation of drainage coefficients; installation of piezometer and observation wells; preparation of iso-bath and isobar maps; determination of drainable porosity; design of surface drainage systems; design of gravel envelop; design of subsurface drainage systems; determination of chemical properties of soil and water; study of drainage tiles and pipes; installation of sub-surface drainage system; cost analysis of surface and sub-surface drainage system.
References	• Bhattacharya AK and Michael AM. 2013. Land Drainage, Principles, Methods and Applications. Vikas Publication House, Noida (UP). • Ritzema H.P.1994 Drainage Principles and Applications, ILRI Publication 16, Second Edition (Completely Revised). • Michael AM. and Ojha TP. 2014. Principles of Agricultural Engineering Vol-II 5th Edition. Jain Brothers Publication, New Delhi. • Kadam U.S., Thokal R.T., Gorantiwar S.D. and Powar A.G. 2007. Agricultural Drainage-Principles and Practices, Westville Publishing House. • FAO Irrigation and Drainage Paper No. 6, 9, 15, 16, 28 and 38. Rome, Italy.
Course Outcomes	At the end of the course, learners will be able **CO1:** Explain the concept of waterlogging, its causes and consequences, and the objectives of drainage. **CO2:** Design and layout surface drainage systems considering topography, rainfall patterns, and soil characteristics. **CO3:** Apply Hooghoudt's and Ernst's equations to calculate drain spacing for optimal subsurface drainage design. **CO4:** Select and install appropriate drainage materials, pipes, and envelopes considering soil and site conditions. **CO5:** Assess the feasibility of bio-drainage, mole drains, and vertical drainage for specific situations. **CO6:** Design leaching strategies for reclaiming saline and alkaline soils based on salt balance and conjunctive water use principles. **CO7:** Analyse soil and water samples to evaluate drainage effectiveness and potential salinity problems.

Mapping between Cos, POs and PSOs

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1															
CO2															
CO3															
CO4															
CO5															
CO6															
CO7															

Course Code	**REE -3.5.8**
Course Title	**Renewable Power Sources**
Course Credit	**3 (2+1)**
Objectives of Course	1. To provide knowledge of solar energy concept and applications. 2. To impart knowledge of geothermal, ocean and tidal energy and their applications. 3. To understand the design of wind mills and applications. 4. To understand the turbines and generators for small scale hydroelectric generation. 5. To understand the important parts of a biogas plant, design and principle of bio-diesel.
Course Content	**Theory:** Energy consumption pattern & energy resources in India. Renewable energy options, potential and utilization. Biogas technology and mechanisms, generation of power from biogas, Power generation from urban, municipal and industrial waste. Design & use of different commercial sized biogas plant. Solar thermal and photovoltaic Systems for power generation. Calculation of energy through photovoltaic power generation and cost economics, Central receiver (Chimney) and distributed type solar power plant, OTEC, MHD, hydrogen and fuel cell technology. Wind farms. Aero-generators. Wind power generation system. Power generation from biomass (gasification & Dendro thermal), Mini and micro small hydel plants. Fuel cells and its associated parameters. **Practical** Performance evaluation of solar water heater; Performance evaluation of solar cooker; Characteristics of solar photovoltaic panel; evaluation of solar air heater/dryer; Performance evaluation of biomass gasifier engine system (throatless & downdraft), Performance evaluation of a fixed dome type biogas plant; Performance evaluation of floating drum type biogas plant; Estimation of calorific value of biogas & producer gas; Testing of diesel engine operation using dual fuel and gas alone.
References	1. Garg H.P. 1990. Advances in Solar Energy Technology; D. Publishing Company, Tokyo. 2. Alan L: Farredbruch & R.H. Buse. 1983. Fundamentals of Solar Academic Press, London. 3. Bansal N.K., Kleemann M. & Meliss Michael. 1990. Renewable Energy Sources & Conversion Technology; Tata Mecgrow Publishing Company, New Delhi. 4. Rathore N. S., Kurchania A. K. & N.L. Panwar. 2007. Non-Conventional Energy Sources, Himanshu Publications. 5. Mathur, A.N. & N.S. Rathore. 1992. Biogas Production Management & Utilization. Himanshu Publications, Udaipur. 6. Khandelwal, K.C. & S.S. Mahdi. 1990. Biogas Technology. 7. Rai, G.D. 2013. Non-Conventional Energy Sources, Khanna Publishers, Delhi. 8. Mathur A.N. & N.S. Rathore. Renewable Energy Sources Bohra Ganesh Publications, Udaipur. 9. Reed TB and Das A. Handbook of Biomass Downdraft Gasifier Engine System. The Biomass Energy Foundation Press, Colorado; 1984.
Course Outcomes	At the end of the course, learners will be able **CO1:** To explain the basic principles of various renewable energy conversion processes and devices used therein **CO2:** To identify various parameters that influences the performance of renewable energy devices/processes.

	CO3: To undertake the field projects in the area of solar thermal, solar PV, wind, biomass, ocean energy, geothermal etc. **CO4:** To identify suitable renewable source and technology for a given requirement To develop the integrated renewable energy technology for decentralized power sector.

Mapping between Cos, POs and PSOs

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1															
CO2															
CO3															
CO4															

Course Code	**CAE -3.5.9**
Course Title	**Skill Development Training – I (Student READY) Registration Only**
Course Credit	**5 (0+5)**
Objectives of Course	• To expose the students to Industrial environment, which cannot be simulated in the university? • To familiarize the students with various Materials, Machines, Processes, Products and their applications along with relevant aspects of shop management. • To make the students understand the psychology of the workers, and approach to problems along with the practices followed at factory • To make the students understand the scope, functions and job responsibility-ties in various departments of an organization.
Course Content	Registration Only – Student READY Skill Development Training - I
Course Outcomes	At the end of the course, learners will be able **CO1**: to understand industrial environment **CO2**: to understand various Materials, Machines, Processes, Products and their applications along with relevant aspects of shop management. **CO3**: to have hands-on-experience and entrepreneurial skills

Mapping between Cos, POs and PSOs

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1															
CO2															
CO3															

Course Code	**FMPE-3.6.2**
Course Title	**Farm Machinery and Equipment-II**
Course Credit	**3 (2 + 1)**
Objectives of Course	1) To get the knowledge about types and components of plant protection, intercultural, harvesting and threshing equipments. 2) To get the knowledge about working, adjustments and calibration of above equipments. 3) To familiarise about some special type of equipments used for harvesting of cash crops, root crops, fruits and vegetable crops.
Course Content	**Theory:** Introduction to plant protection equipment – sprayers and dusters. Classification of sprayers and sprays. Types of nozzles. Calculations for calibration of sprayers

	and chemical application rates. Introduction to interculture equipment. Use of weeders – manual and powered. Study of functional requirements of weeders and main components. Familiarization of fertilizer application equipment. Study of harvesting operation – harvesting methods, harvesting terminology. Study of mowers – types, constructional details, working and adjustments. Study of shear type harvesting devices – cutter bar, inertial forces, counter balancing, terminology, cutting pattern. Study of reapers, binders and windrowers – principle of operation and constructional details. Importance of hay conditioning, methods of hay conditioning, and calculation of moisture content of hay. Introduction to threshing systems – manual and mechanical systems. Types of threshing drums and their applications. Types of threshers- tangential and axial, their constructional details and cleaning systems. Study of factors affecting thresher performance. Study of grain combines, combine terminology, classification of grain combines, study of material flow in combines. Computation of combine losses, study of combine troubles and troubleshooting. Study of chaff cutters and capacity calculations. Study of straw combines – working principle and constructional details. Study of root crop diggers – principle of operation, blade adjustment and approach angle, and calculation of material handled. Study of potato and groundnut diggers. Study of Cotton harvesting – Cotton harvesting mechanisms, study of cotton pickers and strippers, functional components. Study of maize harvesting combines. Introduction to vegetables and fruit harvesting equipment and tools. **Practical:** Familiarization with plant protection and interculture equipment. Study of sprayers, types, functional components. Study of dusters, types and functional components. Calculations for chemical application rates. Study of nozzle types and spread pattern using patternator. Familiarization with manual and powered weeding equipment and identification of functional components. Study of fertilizer application equipment including manure spreaders and fertilizer broadcasters. Study of various types of mowers, reaper, reaper binder. Study of functional components of mowers and reapers. Familiarization with threshing systems, cleaning systems in threshers. Calculations of losses in threshers. Familiarization with functional units of Grain combines and their types. Calculations for grain losses in a combine. Study of root crop diggers and familiarization with the functional units and attachments. Familiarization with the working of cotton and maize harvesters. Familiarization with vegetable and fruit harvesters.
References	• Kepner RA, Roy Barger & EL Barger. Principles of Farm Machinery. • Smith HP and LH Wilkey. Farm Machinery and Equipment. • Culpin Claude. Farm Machinery. • Srivastava AC. Elements of Farm Machinery. • Lal Radhey and AC Datta. Agricultural Engineering.
Course Outcomes	At the end of the course, learners will be able **CO1:** Identify types and components of plant protection, intercultural, harvesting and threshing equipments. **CO2:** Find and repair trouble shooting coming during the operation of above equipments. **CO3: S**elect and identify proper equipments used for harvesting of cash crops, root crops, fruits and vegetable crops.

Mapping between Cos, POs and PSOs

CO	**PO**												**PSO**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1															
CO2															
CO3															

Course Code	PFE-3.6.3
Course Title	Post Harvest Engineering of Horticultural Crops
Course Credit	2 (1 + 1)
Objectives of Course	1. To enable the students to understand concepts of handling various horticultural produces. 2. To apply knowledge of engineering properties for horticultural produce 3. To understand various unit operation involved in processing of horticultural and preservation of horticultural produce. 4. To become aware about the concept of quality and supply chain management
Course Content	**Theory** Importance of processing of fruits and vegetables, spices, condiments and flowers. Characteristics and properties of horticultural crops important for processing, Peeling: Different peeling methods and devices (manual peeling, mechanical peeling, chemical peeling, and thermal peeling), Slicing of horticultural crops: equipment for slicing, shredding, crushing, chopping, juice extraction, etc., Blanching: Importance and objectives; blanching methods, effects on food (nutrition, colour, pigment, texture), Chilling and freezing: Application of refrigeration in different perishable food products, Thermophilic, mesophilic & Psychrophilic micro-organisms, Chilling requirements of different fruits and vegetables, Freezing of food, freezing time calculations, slow and fast freezing, Equipment for chilling and freezing (mechanical & cryogenic), Effect on food during chilling and freezing, Cold storage heat load calculations and cold storage design, refrigerated vehicle and cold chain system, Dryers for fruits and vegetables, Osmodehydration, Packaging of horticultural commodities, Packaging requirements (in terms of light transmittance, heat, moisture and gas proof, microorganisms, mechanical strength), Different types of packaging materials commonly used for raw and processed fruits and vegetables products, bulk and retail packages and packaging machines, handling and transportation of fruits and vegetables, Pack house technology, Minimal processing, Common methods of storage, Low temperature storage, evaporative cooled storage, Controlled atmospheric storage, Modified atmospheric packaging, Preservation Technology, General methods of preservation of fruits and vegetables, Brief description and advantages and disadvantages of different physical/ chemical and other methods of preservation, Flowcharts for preparation of different finished products, Important parameters and equipment used for different unit operations, Post-harvest management and equipment for spices and flowers, Quality control in Fruit and vegetable processing industry. Food supply chain. **Practical** Performance evaluation of peeler and slicer, Performance evaluation of juicer and pulper, Performance evaluation of blanching equipment, Testing adequacy of blanching, Study of cold storage and its design, Study of CAP and MAP storage, Minimal processing of vegetables, Preparation of value added products, Visit to fruit and vegetable processing industry, Visit to spice processing plant
References	Arthey, D. and Ashurst, P. R. 1966. Fruit Processing. Chapman and Hall, New York. Pantastico, E.C.B. 1975. Postharvest physiology, handling and utilization of tropical and subtropical fruits and vegetables AVI Pub. Co., New Delhi. Pandey, R.H. 1997. Postharvest Technology of fruits and vegetables (Principles and practices). Saroj Prakashan, Allahabad. Sudheer, K P. and Indira, V. 2007. Post Harvest Engineering of horticultural crops. New India Publishing House. • Girdhari Lal, G. S. Siddappa, G. L. Tandon, 1986. Preservation of Fruits and Vegetables. Indian Council of Agricultural Research
Course Outcomes	At the end of the course, learners will be able

	CO1: Get knowledge of various different types of sorting, grading, peeling, slicing, blanching and other equipment for processing of fruits and vegetables. **CO2**: Identify the suitable equipment, materials, and methods for storage, processing, packaging, and value addition of fruits and vegetables. **CO3:** Understand the technical and management aspects of the operation of fruits and vegetable processing industries.

Mapping between Cos, POs and PSOs

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1															
CO2															
CO3															

Course Code	**SWCE-3.6.4**
Course Title	**Water Harvesting and Soil Conservation structures**
Course Credit	**3 (2 + 1)**
Objectives of Course	• Comprehend the fundamental principles and significance of water harvesting, delineating its importance in addressing water scarcity issues and exploring various techniques and their classifications based on sourcing, storage, and utilization. • Analyze runoff harvesting methods, distinguishing between short-term (terracing, bunding, rock, and ground catchments) and long-term techniques, elucidating their purposes, design criteria, and operational implications. • Evaluate the design, components, and considerations for constructing farm ponds, percolation ponds, and nala bunds, emphasizing site selection, capacity estimation, spillway design, cost estimation, and construction techniques. • Appraise the diverse soil erosion control structures, categorizing and comprehending their functional requirements, with a special focus on permanent structures such as check dams, drop, chute, and drop inlet spillways, integrating hydrologic, hydraulic, and structural design, stability analysis, and safety measures. • Critically assess the functional characteristics, design criteria, and limitations of different spillway types including straight drop, box-type inlet, chute, and drop inlet spillways, analyzing their structural components, load considerations, energy dissipaters, and safety against various hydraulic forces and structural failure modes.
Course Content	**Theory:** Water harvesting -principles, importance and issues. Water harvesting techniques - classification based on source, storage and use. Runoff harvesting – short-term and long-term techniques. Short-term harvesting techniques - terracing and bunding, rock and ground catchments. Long-term harvesting techniques - purpose and design criteria. Structures - farm ponds - dug-out and embankment reservoir types, tanks and subsurface dykes. Farm pond - components, site selection, design criteria, capacity, embankment, mechanical and emergency spillways, cost estimation and construction. Percolation pond - site selection, design and construction details. Design considerations of *nala* bunds. Soil erosion control structures - introduction, classification and functional requirements. Permanent structures for soil conservation and gully control - check dams, drop, chute and drop inlet spillways - design requirements, planning for design, design procedures - hydrologic, hydraulic and structural design and stability analysis. Hydraulic jump and its application. Drop spillway - applicability, types - straight drop, box-type inlet spillways - description, functional use, advantages and disadvantages, straight apron and stilling basin outlet, structural components and functions. Loads on head wall, variables affecting equivalent fluid pressure, triangular load diagram for various flow conditions, creep line theory, uplift pressure estimation, safety against sliding, overturning, crushing and tension.

	Chute spillway - description, components, energy dissipaters, design criteria of Saint Antony Falls (SAF) stilling basin and its limitations. Drop inlet spillway - description, functional use and design criteria. **Practical:** Study of different types of farm ponds. Computation of storage capacity of embankment type of farm ponds. Design of dugout farm ponds. Design of percolation pond and *nala* bunds. Runoff measurement using H-flume. Exercise on hydraulic jump. Exercise on energy dissipation in water flow. Hydrologic, hydraulic and structural design of drop spillway and stability analysis. Design of SAF stilling basins in chute spillway. Hydrologic, hydraulic and structural design of drop inlet spillway. Design of small earthen embankment structures. Practice on softwares for design of soil and water conservation structures. Field visit to watershed project areas treated with soil and water conservation measures / structures.
References	• Singh Gurmel, C. Venkataraman, G. Sastry and B.P. Joshi. 1996. Manual of Soil and Water Conservation Practices. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi. • Michael, A.M. and T.P. Ojha. 2003. Principles of Agricultural Engineering. Volume II. 4th Edition, Jain Brothers, New Delhi. • Murthy, V.V.N. 2002. Land and Water Management Engineering. 4th Edition, Kalyani Publishers, New Delhi. • Schwab, G.O., D.D. Fangmeier, W.J. Elliot, R.K. Frevert. 1993. Soil and Water Conservation Engineering.4th Edition, John Wiley and Sons Inc. New York. • Suresh, R. 2014. Soil and Water Conservation Engineering. Standard Publisher Distributors, New Delhi. • Samra, J.S., V.N. Sharda and A.K. Sikka. 2002. Water Harvesting and Recycling: Indian Experiences. CSWCR&TI, Dehradun, Allied Printers, Dehradun. • Theib Y. Oweis, Dieter Prinz and Ahmed Y. Hachum. 2012. Rainwater Harvesting for Agriculture in the Dry Areas. CRC Press, Taylor and Francis Group, London. • Studer Rima Mekdaschi and Hanspeter Liniger. 2013. Water Harvesting - Guidelines to Good Practice. • Centre for Development and Environment, University of Bern, Switzerland.
Course Outcomes	At the end of the course, learners will be able CO1: Comprehend the foundational principles and significance of water harvesting, emphasizing its role in addressing water scarcity issues and understanding the diverse classification of water harvesting techniques based on sourcing, storage, and utilization. CO2: Analyze runoff harvesting methods, distinguishing between short-term (terracing, bunding, rock, and ground catchments) and long-term techniques, evaluating their purposes, design criteria, and implementation considerations. CO3: Evaluate the planning, design, and construction aspects of diverse water structures, including farm ponds, percolation ponds, nala bunds, and soil erosion control structures, considering site selection, capacity estimation, spillway design, and stability requirements. CO4: Critically assess permanent soil conservation structures and spillway designs, demonstrating an understanding of hydrologic, hydraulic, and structural design considerations, stability analysis, and safety measures against various hydraulic forces and structural failure modes. CO5: Analyze different spillway types such as drop, chute, and drop inlet spillways, examining their applicability, functional use, advantages, disadvantages, and structural components, emphasizing safety aspects and limitations of designs like Saint Antony Falls (SAF) stilling basin and drop inlet spillways.
Mapping between Cos, POs and PSOs	

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1															
CO2															
CO3															
CO4															
CO5															

Course Code	**IDE-3.6.5**
Course Title	**Groundwater, Wells and Pumps**
Course Credit	**3(2+1)**
Objectives of Course	1. Understand the principles of groundwater occurrence and movement. 2. Design and construct open wells and tubewells. 3. Analyze aquifer parameters and assess groundwater potential. 4. Select and install appropriate pumping systems for different well types. 5. Apply artificial groundwater recharge techniques for sustainable water management.
Course Content	**Theory:** Occurrence and movement of ground water; aquifer and its types; classification of wells, fully penetrating tubewells and open wells, familiarization of various types of bore wells; design of open wells; groundwater exploration techniques; methods of drilling of wells: percussion, rotary, reverse rotary; design of tubewell and gravel pack, installation of well screen, completion and development of well; groundwater hydraulics-determination of aquifer parameters by different method such as Theis, Jacob and Chow's, Theis recovery method; well interference, multiple well systems, estimation of ground water potential, quality of ground water; artificial groundwater recharge techniques; pumping systems: water lifting devices; different types of pumps, classification of pumps, component parts of centrifugal pumps, priming, pump selection, installation and trouble shooting, performance curves, effect of speed on capacity, head and power, effect of change of impeller dimensions on performance characteristics; hydraulic ram, propeller pumps, mixed flow pumps and their performance characteristics; deep well turbine pump and submersible pump. **Practical :** Verification of Darcy's Law; study of different drilling equipments; sieve analysis for gravel and well screens design; estimation of specific yield and specific retention; testing of well screen; estimation of aquifer parameters by Theis method, Coopers-Jacob method, Chow method; Theis Recovery method; well design under confined and unconfined conditions; well losses and well efficiency; estimating ground water balance; study of artificial ground water recharge structures; study of radial flow and mixed flow centrifugal pumps, multistage centrifugal pumps, turbine, propeller and other pumps; installation of centrifugal pump; testing of centrifugal pump and study of cavitations; study of hydraulic ram; study and testing of submersible pump.
References	• Michael AM, Khepar SD. and SK Sondhi. 2008. Water Well and Pumps, 2nd Edition, Tata Mc-Graw • Hill. • Todd David Keith and Larry W. Mays. 2004. Groundwater Hydrology, 3rd Edition, John Wiley & Sons, New York (International Book Distributing Company Lucknow).

	• Michael AM. and Ojha TP. 2014. Principles of Agricultural Engineering Vol-II, 5th Edition. Jain Brothers Publication, New Delhi.
Course Outcomes	At the end of the course, learners will be able **CO1:** Explain the formation and types of aquifers, the different classifications of wells, and the factors influencing well yield. **CO2:** Design open wells and fully penetrating tubewells considering aquifer characteristics and well yield requirements. **CO3:** Apply groundwater exploration techniques and select appropriate well drilling methods based on site conditions. **CO4:** Analyse aquifer parameters using Theis, Jacob, Chow's, and Theis recovery methods and assess well interference. **CO5**: Select and install well screens and gravel packs based on aquifer properties and well design considerations. **CO6:** Select and operate appropriate pumping systems for open wells and tubewells, considering well depth, water requirements, and energy efficiency. **CO7:** Analyse the performance of centrifugal pumps, including head, capacity, efficiency, and cavitation. **CO8:** Evaluate the feasibility and design of artificial groundwater recharge structures for sustainable water management.

Mapping between Cos, POs and PSOs

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1															
CO2															
CO3															
CO4															
CO5															
CO6															
CO7															
CO8															

Course Code	**FMPE-3.6.6**
Course Title	**Tractor and Farm Machinery Operation and Maintenance**
Course Credit	**2 (0+ 2)**
Objectives of Course	1) To get familiarise with different makes and models of agricultural tractor and farm machinery. 2) To get knowledge about regular and periodical maintenance and safety rules and precautions to be observed while driving a tractor. 3) To do the driving practice of tractor alone and tillage tool and their adjustment in the field. 4) To do the practice of replacement of various worn out or broken parts of the farm implement.
Course Content	**Practical :** Familiarization with different makes and models of agricultural tractors. Identification of functional systems including fuels system, cooling system, transmission system, steering and hydraulic systems. Study of maintenance points to be checked before starting a tractor. Familiarization with controls on a tractor. Safety rules and precautions to be observed while driving a tractor. Driving practice of tractor. Practice of operating a tillage tool (mould-board plough/ disc plough) and their adjustment in the field. Study of field patterns while operating a tillage implement. Hitching & De-hitching of mounted and trail type implement to the tractor. Driving practice with a trail type trolley – forward and in reverse

	direction. Introduction to tractor maintenance – precautionary and break-down maintenance. Tractor starting with low battery charge. Introduction to trouble shooting in tractors. Familiarization with tools for general and special maintenance. Introduction to scheduled maintenance after 10, 100, 300, 600, 900 and 1200 hours of operation. Safety hints. Top end overhauling. Fuel saving tips. Preparing the tractor for storage. Care and maintenance procedure of agricultural machinery during operation and off-season. Repair and maintenance of implements – adjustment of functional parameters in tillage implements. Replacement of broken components in tillage implements. Replacement of furrow openers and change of blades of rotavators. Maintenance of cutter bar in a reaper. Adjustments in a thresher for different crops. Replacement of V-belts on implements. Setting of agricultural machinery workshop.
References	**Reference Books** • Ghosh RK and S Swan. Practical Agricultural Engineering. • Black PO and WE Scahill. Diesel Engine Manual. • Southorn N. Tractor operation and maintenance. • Jain SC and CR Rai. Farm Tractor Maintenance and Repair. • Operators manuals of tractors. • Service manuals provided by manufacturers.
Course Outcomes	At the end of the course, learners will be able **CO1**: Identify and select suitable makes and models of agricultural tractor and farm machinery. **CO2**: Do regular and periodical maintenance of the tractor. **CO3**: Able to drive tractor alone and along with tillage tools. **CO4**: Able to replace worn out or broken parts of the farm implement.

Mapping between Cos, POs and PSOs

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1															
CO2															
CO3															
CO4															

Course Code	**REE -3.6.8**
Course Title	**Bio-Energy Systems: Design and Applications**
Course Credit	**3 (2+1)**
Objectives of Course	1.To disseminate the importance of bioenergy systems. 2.To acquire knowledge on cutting-edge technologies for conversion of various biomass feedstock to bioenergy / biofuel production and their utilization in combustion engines / devices. 3.To design the different bio energy generation systems. On successful completion of the course, the students would be able to contribute towards providing biomass based sustainable energy solutions.
Course Content	**Theory:** Fermentation processes and its general requirements, An overview of aerobic and anaerobic fermentation processes and their industrial application. Heat transfer processes in anaerobic digestion systems, land fill gas technology and potential. Biomass Production: Wastelands, classification and their use through energy plantation, selection of species, methods of field preparation and transplanting. Harvesting of biomass and coppicing characteristics. Biomass preparation techniques for harnessing (size reduction, densification and drying). Thermo-chemical degradation. History of small gas producer engine system. Chemistry of gasification. Gas producer – type, operating principle. Gasifier fuels, properties, preparation, conditioning of producer gas. Application, shaft power

	generation, thermal application and economics. Trans-esterification for biodiesel production. A range of bio-hydrogen production routes. Environmental aspect of bio-energy, assessment of greenhouse gas mitigation potential. **Practicals:** Study of anaerobic fermentation system for industrial application, Introduction of insulation and different types of insulation used in renewable energy gadgets, Study of gasification for industrial process heat, Study of biodiesel production unit, Study of biomass densification technique (briquetting, pelletization, and cubing), Integral bio energy system for industrial application, Study of bio energy efficiency in industry and commercial buildings, Study and demonstration of energy efficiency in building.
References	1. British BioGen. 1997, Anaerobic digestion of farm and food processing practices- Good practice guidelines, London, available on www.britishbiogen.co.UK. 2. Butler, S. 2005. Renewable Energy Academy: Training wood energy professionals. 3. Centre for biomass energy. 1998. Straw for energy production; Technology-Environment- Ecology. Available: www.ens.dk. Reed TB and Das A. 4. Handbook of Biomass Downdraft Gasifier Engine System. The Biomass Energy Foundation Press, Colorado; 1984.
Course Outcomes	At the end of the course, learners will be able **CO1:** To characterize different biomass feedstocks based on its constituents and properties **CO2:** To understand and evaluate various biomass pretreatment and processing techniques in terms of their applicability for different biomass type for biomass conversion processes **CO3:** To understand the process of combustion, pyrolysis, gasification and liquefaction for production of value added bio-products, biogas, bio-CNG generation etc. **CO4.** To understand basics of biofuels, their production technologies and applications in various energy utility routes

Mapping between Cos, POs and PSOs

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1															
CO2															
CO3															
CO4															

Course Code	**CAE-4.7.1**
Course Title	**10- weeks Industrial Attachment /Internship (Student READY)**
Course Credit	**5 (0+10)**
Objectives of Course	• To provide rural entrepreneurship awareness, practical experience in real-life situation in rural agriculture and creating awareness to undergraduate students about practical agriculture and allied sciences. • To build confidence, skill and acquire Indigenous Technical Knowledge (ITK) of the locality to prepare the pass-out for self-employment • To provide opportunities to acquire hands-on-experience and entrepreneurial skills
Course Content	Registration Only – 10- weeks Industrial Attachment /Internship (Student READY)
Course Outcomes	At the end of the course, learners will be able

	CO1: to have practical experience in real-life situation in rural agriculture and have awareness about practical agriculture and allied sciences **CO2**: to have know how about entrepreneurship. **CO3**: to have hands-on-experience and entrepreneurial skills

Mapping between Cos, POs and PSOs

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1															
CO2															
CO3															

Course Code	**CAE-4.7.2**
Course Title	**10- weeks Experiential Learning On campus (Student READY)**
Course Credit	**5 (0+10)**
Objectives of Course	• To provide rural entrepreneurship awareness, practical experience in real-life situation in rural agriculture and creating awareness to undergraduate students about practical agriculture and allied sciences. • To build confidence, skill and acquire Indigenous Technical Knowledge (ITK) of the locality to prepare the pass-out for self-employment • To provide opportunities to acquire hands-on-experience and entrepreneurial skills
Course Content	Registration Only – 10- weeks Experiential Learning On campus (Student READY)
Course Outcomes	At the end of the course, learners will be able **CO1**: to have practical experience in real-life situation in rural agriculture and have awareness about practical agriculture and allied sciences **CO2**: to have know how about entrepreneurship. **CO3**: to have hands-on-experience and entrepreneurial skills

Mapping between Cos, POs and PSOs

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1															
CO2															
CO3															

ourse Code	**CAE-4.7.3**
Course Title	**Skill Development Training – II (Student READY) Registration Only**
Course Credit	**5 (0+5)**
Objectives of Course	• To expose the students to Industrial environment, which cannot be simulated in the university. • To familiarize the students with various Materials, Machines, Processes, Products and their applications along with relevant aspects of shop management. • To make the students understand the psychology of the workers, and approach to problems along with the practices followed at factory • To make the students understand the scope, functions and job responsibility-ties in various departments of an organization.
Course Content	Registration Only – Student READY Skill Development Training - II
Course Outcomes	At the end of the course, learners will be able **CO1**: to understand industrial environment

	CO2: to understand various Materials, Machines, Processes, Products and their applications along with relevant aspects of shop management. **CO3**: to have hands-on-experience and entrepreneurial skills

Mapping between Cos, POs and PSOs

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1															
CO2															
CO3															

Course Code	**CAE-4.7.4**
Course Title	**Educational Tour (Registration only)**
Course Credit	**2 (0+2)**
Objectives of Course	• To provide rural entrepreneurship awareness, practical experience in real-life situation in rural agriculture and creating awareness to undergraduate students about practical agriculture and allied sciences. • To build confidence, skill and acquire Indigenous Technical Knowledge (ITK) of the locality to prepare the pass-out for self-employment • To provide opportunities to acquire hands-on-experience and entrepreneurial skills
Course Content	Registration Only – Educational Tour of 15 days duration to various industries within and / or outside the state of the University and submission of report on Industrial Tour.
Course Outcomes	At the end of the course, learners will be able **CO1**: to have practical experience in real-life situation in rural agriculture and have awareness about practical agriculture and allied sciences **CO2**: to have know how about entrepreneurship. **CO3**: to have hands-on-experience and entrepreneurial skills

Mapping between Cos, POs and PSOs

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1															
CO2															
CO3															

Course Code	**CAE-4.8.4**
Course Title	**Project Planning and Report Writing**
Course Credit	**3 (2 + 1)**
Objectives of Course	• To develop the ability to solve a specific problem right from its identification and literature review till the successful solution of the same. • To train the students in preparing project reports and to face reviews and viva voce examination.
Course Details	Students in a group of 2 shall work on a topic approved by the head of the department under the guidance of a faculty member and prepare a comprehensive project report after completing the work to the satisfaction of the supervisor.

	The project work is evaluated based on oral presentation and the final project report jointly by a team of examiners including one external examiner.
Course Outcomes	At the end of the course, learners will be able CO1: Identify agricultural engineering problems reviewing available literature. CO2: Identify appropriate techniques to analyse complex agricultural engineering problems. CO3: Apply engineering and management principles through efficient handling of project, have a clear idea of his/her area of work and they are in a position to carry out the work in a systematic way

Mapping between Cos, POs and PSOs

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1															
CO2															
CO3															

Course Code	**SWCE-4.8.1**
Course Title	**Floods and Control Measures**
Course Credit	**3 (2 + 1)**
Objectives of Course	• Analyze the various causes of flood occurrences and classify floods, including probable maximum flood, standard project flood, and design flood, emphasizing their significance in flood estimation and management strategies. • Evaluate the diverse methods employed in flood estimation, such as rational methods, empirical techniques, and unit hydrograph methods, and apply statistical tools like log normal, Gumbel's extreme value, and log-Pearson type-III distributions for flood frequency analysis. • Assess flood forecasting techniques and flood routing methodologies like channel routing, Muskingum method, reservoir routing, and modified Pul's method, emphasizing their application in predicting and managing flood events. • Examine flood control measures historically and compare structural (storage reservoirs, levees, channel improvements) and non-structural strategies in flood mitigation, focusing on gully erosion control structures, ravine control, river training works, and planning flood control projects. • Evaluate the design, construction, and stability aspects of different types of earthen embankments, including hydraulic fill, rolled fill dams, zoned, diaphragm type, and subsurface dams, analyzing their structural integrity against seepage, piping, and failure modes.
Course Content	**Theory:** Floods - causes of occurrence, flood classification - probable maximum flood, standard project flood, design flood, flood estimation - methods of estimation; estimation of flood peak -

	rational method, empirical methods, unit hydrograph method. Statistics in hydrology, flood frequency methods - log normal, Gumbel's extreme value, log-Pearson type-III distribution; depth-area-duration analysis. Flood forecasting. Flood routing - channel routing, Muskingum method, reservoir routing, modified Pul's method. Flood control - history of flood control, structural and non-structural measures of flood control, storage and detention reservoirs, levees, channel improvement. Gully erosion and its control structures design and implementation. Ravine control measures. River training works, planning of flood control projects and their economics. Earthen embankments - functions, classification - hydraulic fill and rolled fill dams - homogeneous, zoned and diaphragm type, foundation requirements, grouting, seepage through dams, flow net and its properties, seepage pressure, seepage line in composite earth embankments, drainage filters, piping and its causes. Design and construction of earthen dam, stability of earthen embankments against failure by tension, overturning, sliding etc., stability of slopes - analysis of failure by different methods. Subsurface dams - site selection and constructional features. Check dam - Small earthen embankments - types and design criteria. Subsurface dams - site selection and constructional features. **Practical:** Determination of flood stage-discharge relationship in a watershed. Determination of flood peak-area relationships. Determination of frequency distribution functions for extreme flood values using Gumbel's method. Determination of confidence limits of the flood peak estimates for Gumbel's extreme value distribution. Determination of frequency distribution functions for extreme flood values using log-Pearson Type-III distribution. Determination of probable maximum flood, standard project flood and spillway design flood. Design of levees for flood control. Design of jetties. Study of vegetative and structural measures for gully stabilization. Design of gully/ravine control structures and cost estimation. Designing, planning and cost- benefit analysis of a flood control project. Study of different types, materials and design considerations of earthen dams. Determination of the position of phreatic line in earth dams for various conditions, stability analysis of earthen dams against head water pressure, foundation shear, sudden draw down condition etc. Stability of slopes of earth dams by friction circle and other methods. Construction of flow net for isotropic and anisotropic media. Computation of seepage by different methods. Determination of settlement of earth dam. Input-output-storage relationships by reservoir routing. Visit to sites of earthen dam and water harvesting structures.
References	• Michael, A.M. and T.P. Ojha. 2003. Principles of Agricultural Engineering. Volume II. 4th Edition, Jain Brothers, New Delhi.

- Murthy, V.V.N. 2002. Land and Water Management Engineering. 4th Edition, Kalyani Publishers, New Delhi.
- Suresh, R. 2014. Soil and Water Conservation Engineering. Standard Publisher Distributors, New Delhi.
- Mutreja, K.N. 1990. Applied Hydrology. Tata McGraw-Hill Publishing Co., New York, Delhi.
- Subramanya, K. 2008. Engineering Hydrology. 3rd Edition, Tata McGraw-Hill Publishing Co., New Delhi.
- Bureau of Reclamation. 1987. Design of Small Dams. US Department of Interior, Washington DC, USA. Arora, K.R. 2014. Soil Mechanics and Foundation Engineering (Geotechnical Engineering). Standard Publishers Distributors, Delhi.
- Garg, S.K. 2014. Soil Mechanics and Foundation Engineering. Khanna Publishers Pvt. Ltd., New Delhi. Stephens Tim. 2010. Manual on Small Earth Dams - A Guide to Siting, Design and Construction. Food and Agriculture Organization of the United Nations, Rome.

Course Outcomes

At the end of the course, learners will be able

CO1: Understand the causes and classifications of floods, recognizing their importance in flood estimation and flood management techniques.

CO2: Apply various flood estimation methods and statistical tools for flood frequency analysis and depth-area-duration assessments.

CO3: Evaluate different flood forecasting and routing techniques, demonstrating proficiency in predicting and managing flood events.

CO4: Analyze flood control measures, distinguishing between structural and non-structural approaches, emphasizing erosion control and river training works.

CO5: Assess the design, construction, and stability considerations of earthen embankments and subsurface dams, ensuring their integrity against seepage and potential failure modes.

Mapping between Cos, POs and PSOs

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1															
CO2															
CO3															
CO4															
CO5															

Course Code	**SWCE-4.8.2**
Course Title	**Wasteland Development**
Course Credit	**3 (2 + 1)**
Objectives of Course	• Analyze the concept of land degradation, its classification concerning various regions (arid, semiarid, humid, and sub-humid), and assess the

	factors leading to denuded range lands and wastelands, emphasizing their mapping and planning for development. • Evaluate conservation structures such as gully stabilization, ravine rehabilitation, sand dune stabilization, and water harvesting methods, emphasizing their role in combating land degradation and facilitating wasteland reclamation and sustainable development. • Explore afforestation techniques including agro-horti-forestry-silvipasture methods, and optimal land use options like forage and fuel crops, examining their socioeconomic constraints and benefits in reclaiming and developing wastelands. • Assess wasteland development strategies in diverse geographical areas including hills, semi-arid regions, coastal areas, water-scarce zones, and initiatives for reclaiming waterlogged and salt-affected lands, incorporating micro-irrigation practices and sustainable management approaches. • Critically analyze government policies, participatory approaches, and the formulation of proposals for wasteland development, emphasizing benefit-cost analysis and considering socio-economic perspectives and sustainable solutions during drought situations.
Course Content	**Theory** Land degradation – concept, classification - arid, semiarid, humid and sub-humid regions, denuded range land and marginal lands. Wastelands - factors causing, classification and mapping of wastelands, planning of wastelands development - constraints, agro-climatic conditions, development options, contingency plans. Conservation structures - gully stabilization, ravine rehabilitation, sand dune stabilization, water harvesting and recycling methods. Afforestation - agro-horti-forestry-silvipasture methods, forage and fuel crops - socioeconomic constraints. Shifting cultivation, optimal land use options. Wasteland development – hills, semi-arid, coastal areas, water scarce areas, reclamation of waterlogged and salt-affected lands. Mine spoils- impact, land degradation and reclamation and rehabilitation, slope stabilization and mine environment management. Micro-irrigation in wastelands development. Sustainable wasteland development - drought situations, socio-economic perspectives. Government policies. Participatory approach. Preparation of proposal for wasteland development and benefit-cost analysis. **Practical:** Mapping and classification of wastelands. Identification of factors causing wastelands. Estimation of vegetation density and classification. Planning and design of engineering measures for reclamation of wastelands. Design and estimation of different soil and water conservation structures under arid, semiarid and humid conditions. Planning and design of micro-irrigation in wasteland development. Cost estimation of the above measures / structures. Visit to wasteland development project sites.
References	• Abrol, I.P., and V.V. Dhruvanarayana. 1998. Technologies for Wasteland Development. ICAR, New Delhi. • Ambast, S.K., S.K. Gupta and Gurcharan Singh (Eds.) 2007. Agricultural Land Drainage - Reclamation of Waterlogged Saline Lands. Central Soil Salinity Research Institute, Karnal, Haryana. • Hridai Ram Yadav. 2013. Management of Wastelands. Concept Publishing Company. New Delhi. • Karthikeyan, C., K. Thangaraja, C. Cinthia Fernandez and K. Chandrakandon. 2009. Dryland Agriculture and Wasteland Management. Atlantic Publishers and Distributors Pvt. Ltd., New Delhi.

	• Rattan Lal and B.A. Stewart (Ed.). 2015. Soil Management of Smallholder Agriculture. Volume 21 of Advances in Soil Science. CRC Press, Taylor and Francis Group, Florida, USA. • Robert Malliva and Thomas Missimer. 2012. Arid Lands Water Evaluation and Management. Springer Heidelberg, New York. • Swaminathan, M.S. 2010. Science and Integrated Rural Development. Concept Publishing Company (P) Ltd., Delhi. • The Energy and Resources Institute. 2003. Looking Back to Think Ahead-Green India 2047. Growth with Resource Enhancement of Environment and Nature. New Delhi. • Virmani, S.M. (Ed.). 2010. Degraded and Wastelands of India: Status and Spatial Distribution. ICAR, New Delhi.
Course Outcomes	At the end of the course, learners will be able CO1: Understand the concept of land degradation and wastelands, proficiently classifying and mapping them based on diverse agro-climatic conditions, and identifying constraints and development options. CO2: Evaluate and apply conservation structures and reclamation methods for gully stabilization, ravine rehabilitation, sand dune stabilization, and water harvesting, demonstrating their effectiveness in combating land degradation. CO3: Analyze afforestation techniques and optimal land use options, including agro-horti-forestry methods and forage/fuel crops, assessing their socio-economic constraints and potential for reclaiming and developing wastelands sustainably. CO4: Assess diverse wasteland development strategies, including reclamation approaches for varied geographical areas and mine spoils, integrating micro-irrigation practices and sustainable management in drought situations. CO5: Critically appraise government policies, participatory approaches, and the formulation of proposals for wasteland development, showcasing proficiency in conducting benefit-cost analyses and incorporating socio-economic perspectives for sustainable solutions.

Mapping between Cos, POs and PSOs

CO	PO												PSO		
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CO4															
CO5															

Course Code	**SWCE-4.8.3**
Course Title	**Information Technology for Land and Water Management**
Course Credit	**3 (2 + 1)**
Objectives of Course	• Evaluate the role of Information Technology (IT) in natural resources management, emphasizing its potential for efficient data handling, analysis, and decision-making processes. • Analyze existing systems and organizations involved in land and water management, focusing on information generation, multimedia application, web technology, and networking tools to comprehend their functionalities and limitations. • Explore the development of database concepts for effective natural resources management, employing rational data management systems, object-oriented

	approaches, and decision support systems, along with expertise in remote sensing, GIS, GPS, and multi-sensor data loggers. • Examine agricultural information management systems, their utilization of mathematical models and programs, and the overview of software packages relevant to natural resource management, emphasizing video-conferencing for scientific information exchange. • Assess problems, prospects, and future advancements in new information and communication technology within the context of natural resource management, focusing on decision-making systems and expert systems' application potential.
Course Content	**Theory** Concept of Information Technology (IT) and its application potential. Role of IT in natural resources management. Existing system of information generation and organizations involved in the field of land and water management. Application and production of multimedia. Internet application tools and web technology. Networking system of information. Problems and prospects of new information and communication technology. Development of database concept for effective natural resources management. Application of remote sensing, geographic information system (GIS) and GPS. Rational data base management system. Object oriented approaches. Information system, decision support systems and expert systems. Agricultural information management systems - use of mathematical models and programmes. Application of decision support systems, multi sensor data loggers and overview of software packages in natural resource management. Video-conferencing of scientific information. **Practical** Practical: Multimedia production. Internet applications: E-mail, voice mail, web tools and technologies. Handling and maintenance of new information technologies and exploiting their potentials. Exercises on database management using database and spreadsheet programmes. Usage of remote sensing, GIS and GPS survey in information generation and processing. Exercises on running computer software packages dealing with water balance, crop production, land development, land and water allocation, watershed analysis etc. Exercises on simple decision support and expert systems for management of natural resources. Multimedia production using different softwares. Exercises on development of information system on selected theme(s). Video-conferencing of scientific information.
References	• Climate-Smart Agriculture – Source Book. 2013. Food and Agriculture Organization, Rome. • Daniel P. Loucks and Eelco van Beek. 2005. Water Resources Systems Planning and Management - An Introduction to Methods, Models and Applications. UNESCO, Paris. • Dipak De and Basavaprabhu Jirli (Eds.). 2010. Communication Support for Sustainable Development. • Ganga Kaveri Publishing House, Varanasi – 221001. • FAO. 1998. Land and Water Resources Information Systems. FAO Land and Water Bulletin 7, Rome. Fuling Bian and Yichun Xie (Eds.). 2015. Geo-Informatics in Resource Management and Sustainable Ecosystem. Springer, New York. • ICFAI Business School (IBS). 2012. Information Technology and Systems. IBS Centre for Management Research, Hyderabad.

	• Robert Malliva and Thomas Missimer. 2012. Arid Lands Water Evaluation and Management. Environmental Science. Springer, New York. • Sarvanan. R. 2011. Information and Communication Technology for Agriculture and Rural Development. New India Publishing Agency, New Delhi. • Soam, S.K., P.D. Sreekanth and N.H. Rao (Eds.). 2013. Geospatial Technologies for Natural Resources Management. New India Publishing Agency, Delhi.
Course Outcomes	At the end of the course, learners will be able CO1: Understanding IT Concepts and Role in Resource Management Gain a comprehensive understanding of Information Technology concepts and its pivotal role in managing natural resources efficiently and sustainably. CO2: Application Proficiency of IT in Natural Resource Management Apply various IT tools and methodologies for the effective management of land and water resources, including multimedia production, database development, and utilization of remote sensing, GIS, and GPS. CO3: Information Systems Development for Resource Management Develop information systems and databases, applying rational database management principles and object-oriented approaches tailored for efficient natural resources management. CO4: Utilizing Decision Support Systems and Expert Systems Utilize decision support systems, expert systems, and agricultural information management systems involving mathematical models, multi-sensor data loggers, and software packages for effective decision-making in resource management. CO5: Communication and Collaboration in Resource Management Effectively utilize internet application tools, web technology, and video-conferencing methods to disseminate scientific information and facilitate collaboration among stakeholders in natural resources management.

Mapping between Cos, POs and PSOs

CO	PO												PSO		
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Course Code	**SWCE-4.8.4**
Course Title	**Remote Sensing and GIS Applications**
Course Credit	**3 (2 + 1)**
Objectives of Course	• Acquire a holistic understanding of remote sensing, encompassing its components, limitations, and GIS techniques for land and water resource assessment and monitoring. • Develop practical proficiency in utilizing remote sensing and GIS tools for integrated data analysis, aiding informed decision-making in resource management practices. • Gain competence in aerial photography principles, stereoscopic vision, and interpretation, facilitating efficient spatial data acquisition and analysis. • Master image analysis techniques, including restoration, enhancement, and classification, enabling extraction of meaningful insights from remotely sensed data.

	• Apply combined knowledge of remote sensing and GIS to efficiently manage land and water resources, employing integration and decision support systems for sustainable practices.
Course Content	Basic component of remote sensing (RS), advantages and limitations of RS, possible use of RS techniques in assessment and monitoring of land and water resources; electromagnetic spectrum, energy interactions in the atmosphere and with the Earth's surface; major atmospheric windows; principal applications of different wavelength regions; typical spectral reflectance curve for vegetation, soil and water; spectral signatures; different types of sensors and platforms; contrast ratio and possible causes of low contrast; aerial photography; types of aerial photographs, scale of aerial photographs, planning aerial photography- end lap and side lap; stereoscopic vision, requirements of stereoscopic photographs; airphoto interpretation- interpretation elements; photogrammetry- measurements on a single vertical aerial photograph, measurements on a stereo-pair- vertical measurements by the parallax method; ground control for aerial photography; satellite remote sensing, multispectral scanner- whiskbroom and push-broom scanner; different types of resolutions; analysis of digital data- image restoration; image enhancement; information extraction,image classification, unsupervised classification, supervised classification, important consideration in the identification of training areas, vegetation indices; microwave remote sensing. GI Sand basic components, different sources of spatial data, basic spatial entities, major components of spatial data, Basic classes of map projections and their properties, Methods of data input into GIS, Data editing, spatial data models and structures, Attribute data management, integrating data (map overlay) in GIS, Application of remote sensing and GIS for the management of land and water resources.
References	• Reddy Anji, M. 2006. Textbook of Remote Sensing and Geographical Information Systems. BS Publications, Hyderabad. • Elangovan, K. 2006. GIS Fundamentals Applications and Implementations. New India Publication Agency, New Delhi. • George Joseph. 2005. Fundamentals of Remote Sensing. 2nd Edition. Universities Press (India) Private Limited, Hyderabad. • Jensen, J.R. 2013. Remote Sensing of the Environment: An Earth Resource Perspective. Pearson Education Limited, UK. • Lillesand, T., R.W. Kiefer and J. Chipman. 2015. Remote Sensing and Image Interpretation. 7th Edition, John Wiley and Sons Singapore Pvt. Ltd., Singapore. • Sabins, F.F. 2007. Remote Sensing: Principles and Interpretation. Third Edition, Waveland Press Inc., Illinois, USA. • Sahu, K.C. 2008. Text Book of Remote Sensing and Geographic Information Systems. Atlantic Publishers and Distributors (P) Ltd., New Delhi. • Shultz, G.A. and E.T. Engman. 2000. Remote Sensing in Hydrology and Water Management. Springer, • New York
Course Outcomes	At the end of the course, learners will be able CO1: Understand the foundational principles and applications of remote sensing techniques for assessing and monitoring land and water resources CO2: Analyze energy interactions within the electromagnetic spectrum and comprehend sensor technologies used in remote sensing, aerial photography, and satellite-based observations. CO3: Apply photogrammetric principles, aerial photography techniques, and interpretative skills to extract meaningful information for land and water resource management.

	CO4: Evaluate satellite remote sensing technologies, digital image analysis methods, and classification techniques for processing and interpreting Earth observation data. CO5: Demonstrate proficiency in Geographic Information System (GIS) fundamentals, spatial data management, map projections, and their application in optimizing land and water resource management strategies.

Mapping between Cos, POs and PSOs

CO	PO												PSO		
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Course Code	**IDE-4.8.5**
Course Title	**Management of Canal Irrigation System**
Course Credit	**3(2+1)**
Objectives of Course	1. Understand the principles and benefits of canal irrigation systems. 2. Analyze the performance of canal networks and identify areas for improvement. 3. Design and manage irrigation canals based on water requirements and silt theory principles. 4. Implement efficient water distribution methods like warabandhi and canal schedules. 5. Evaluate the need and design of canal linings, escapes, and other essential structures.
Course Content	**Theory:** Purpose benefits and ill effects of irrigation; typical network of canal irrigation system and its different physical components; canal classification based on source of water, financial output, purpose, discharge and alignment; canal alignment: general considerations for alignment; performance indicators for canal irrigation system evaluation, Estimation of water requirements for canal command areas and determination of canal capacity; water duty and delta, relationship between duty, base period and delta, factors affecting duty and method of improving duty; silt Theory: Kennedy's theory, design of channels by Kennedy's theory, Lacey's regime theory and basic regime equations, design of channels by Lacey's theory, maintenance of unlined irrigation canals, measurement of discharge in canals, rostering (canal running schedule) and warabandhi, necessity of canal lining: advantages and disadvantages, types of canal lining and desirable characteristics for the suitability of lining materials; design of lined canals; functions of distributary head and cross regulators; canal falls, their necessity and factors affecting canal fall; sources of surplus water in canals and types of canal escapes; requirements of a good canal outlet and types of outlet. **Practical:** Estimation of water requirement of canal commands; determination of canal capacity; layout of canal alignments on topographic maps, drawing of canal sections in cutting, full banking and partial cutting and partial banking; determination of longitudinal section of canals; design of irrigation canals based on silt theories; design of lined canals; formulation of warabandhi; Study of canal outlets, regulators, escapes and canal falls.

References	• Arora, K.R. 2001. Irrigation, Water Power and Water Resources Engineering. Standard Publishers Distributors, Delhi. • Garg S. K. 2014. Irrigation Engineering and Hydraulic Structures, Khanna Publishers New Delhi. Sahasrabudhe SR. 2011. Irrigation Engineering and Hydraulic structures. SK Kataria & Sons Reprint 2015.
Course Outcomes	At the end of the course, learners will be able **CO1:** Explain the purpose, benefits, and potential drawbacks of canal irrigation systems, including their components and classification. **CO2:** Analyze water requirements for canal command areas and determine the required canal capacity using appropriate methods. **CO3:** Apply and compare silt theories like Kennedy's and Lacey's for efficient canal design and maintenance. **CO4:** Design and implement rosters (canal running schedules) and warabandhi for equitable and efficient water distribution. **CO5:** Evaluate the need for and design of canal lining, falls, escapes, outlets, and other structures considering technical and economic factors.

Mapping between COs with POs and PSOs

Mapping between Cos, POs and PSOs

CO	PO												PSO		
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Course Code	**IDE-4.8.6**
Course Title	**Minor Irrigation and Command Area Development**
Course Credit	**3(2+1)**
Objectives of Course	1. Understand the importance and types of minor irrigation systems. 2. Design and manage lift irrigation and tank irrigation systems. 3. Implement command area development (CAD) programs for improved water management. 4. Analyze water productivity and identify strategies for enhancement. 5. Promote farmer participation in irrigation development and management.
Course Content	**Theory:** Factors affecting performance of irrigation projects; types of minor irrigation systems in India; lift irrigation systems: feasibility, type of pumping stations and their site selection, design of lift irrigation systems; tank Irrigation: grouping of tanks, storage capacity, supply works and sluices; command area development (CAD) programme- components, need, scope, and development approaches, historical perspective, command area development authorities functions and responsibilities; on farm development works, reclamation works, use of remote sensing techniques for CAD works; water productivity: concepts and measures for enhancing water productivity; Farmers' participation in command area development; **Practical:** Preparation of command area development layout plan; Irrigation water requirement of crops; Preparation of irrigation schedules; Planning and layout of water conveyance system; design of surplus weir of tanks; determination of storage capacity of tanks; design of intake pipe and pump house.

References	• Arora, K.R. 2001. Irrigation, Water Power and Water Resources Engineering. Standard Publishers Distributors, Delhi. • Garg S. K. 2014. Irrigation Engineering and Hydraulic Structures, Khanna Publishers New Delhi. • Michael A.M. 2012. Irrigation: Theory and Practice. Vikas Publishing Vikas Publ. House New Delhi. Sahasrabudhe SR. 2011. Irrigation Engineering and Hydraulic structures. SK Kataria & Sons Reprint 2015.
Course Outcomes	At the end of the course, learners will be able **CO1:** Explain the factors affecting performance of irrigation projects and differentiate between major and minor irrigation systems. **CO2:** Analyse the feasibility and design lift irrigation systems, including pumping station selection and system layout. **CO3:** Assess tank irrigation systems, including storage capacity, supply works, and sluice design. **CO4**: Explain the principles and components of command area development programs, highlighting their historical context and objectives. **CO5**: Develop command area layout plans, irrigation schedules, water conveyance systems, and farm development works. **CO6**: Analyse water productivity, identify factors affecting it, and propose strategies for improvement. **CO7**: Explain the role of farmer participation in command area development and identify ways to encourage their involvement.

Mapping between Cos, POs and PSOs

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Course Code	**IDE-4.8.7**
Course Title	**Precision Farming Techniques for Protected Cultivation**
Course Credit	**3(2+1)**
Objectives of Course	1. Understand the principles and benefits of protected cultivation. 2. Design and construct greenhouses and manage their environment (light, temperature, humidity, CO2). 3. Implement precision irrigation and fertigation techniques for optimal plant growth. 4. Employ appropriate methods for pest and disease control in greenhouse environments. 5. Select suitable crops for protected cultivation and manage their production efficiently. 6. Conduct economic analysis of greenhouse projects.
Course Content	**Theory:** Protected cultivation: Introduction, History, origin, development, National and International Scenario, components of green house, perspective, Types of green houses, polyhouses /shed nets, Cladding materials, Plant environment interactions – principles of limiting factors, solar radiation and transpiration, greenhouse effect, light, temperature, relative humidity, carbon

	dioxide enrichment, Design and construction of greenhouses – site selection, orientation, design, construction, design for ventilation requirement using exhaust fan system, selection of equipment, Greenhouse cooling system – necessity, methods – ventilation with roof and side ventilators, evaporative cooling, different shading material fogging, combined fogging and fan-pad cooling system, design of cooling system, maintenance of cooling and ventilation systems, pad care etc. Greenhouse heating – necessity, components, methods, design of heating system. Root media – types – soil and soil less media, composition, estimation, preparation and disinfection, bed preparation. Planting techniques in green house cultivation. Irrigation in greenhouse and net house – Water quality, types of irrigation system, components, design, installation, and material requirement. Fogging system for greenhouses and net houses – introduction, benefits, design, installation, and material requirement. Maintenance of irrigation and fogging systems. Fertilization – nutrient deficiency symptoms and functions of essential nutrient elements, principles of selection of proper application of fertilizers, fertilizer scheduling, rate of application of fertilizers, methods, automated fertilizer application. Greenhouse climate measurement, control and management. Insect and disease management in greenhouse and net houses. Selection of crops for greenhouse cultivation, major crops in greenhouse – irrigation requirement, fertilizer management, cultivation, harvesting and post-harvest techniques; Economic analysis. **Practical:** Estimation of material requirement for construction of greenhouse ; Determination of fertilization schedule and rate of application for various crops; Estimation of material requirement for preparation of root media; Root media preparation, bed preparation and disinfections; Study of different planting techniques ; Design and installation of irrigation system; Design and installation of fogging system ; Greenhouse heating; Study of different greenhouse environment control instruments; Study of operation maintenance and fault detection in irrigation system; Study of operation maintenance and fault detection in fogging system; Economic analysis of greenhouses and net houses; Visit to greenhouses.
References	• Singh Brahma and Balraj Singh. 2014. Advances in protected cultivation, New India Publishing Company. • Sharma P. 2007. Precision Farming. Daya Publishing House New Delhi.
Course Outcomes	At the end of the course, learners will be able **CO1**: Explain the concepts of protected cultivation, its history, types of greenhouses, and their components. **CO2**: Design and construct greenhouses considering site selection, orientation, construction materials, and ventilation requirements. **CO3**: Implement and manage greenhouse cooling and heating systems using appropriate technology and control mechanisms. **CO4**: Select and prepare suitable root media, implement appropriate planting techniques, and design and install irrigation and fogging systems for efficient water management. **CO5**: Develop fertilization schedules and apply fertilizers effectively based on plant needs and soil conditions. **CO6**: Explain the principles of greenhouse climate measurement and control and utilize appropriate instruments for monitoring and managing environmental parameters. **CO7**: Identify and manage common insect and disease problems in greenhouse environments using effective and sustainable methods. **CO8**: Select suitable crops for protected cultivation, manage their irrigation, fertilization, and cultivation practices, and implement appropriate harvesting and post-harvest techniques.

	CO9: Conduct economic analysis of greenhouse projects, considering initial investment, operational costs, and potential benefits.

Mapping between COs with POs and PSOs

Mapping between Cos, POs and PSOs

CO	PO												PSO		
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Course Code	**IDE-4.8.8**
Course Title	**Water Quality and Management Measures**
Course Credit	**3 (2 + 1)**
Objectives of Course	1. Understand the natural factors affecting water quality and the various water quality standards. 2. Identify and differentiate between point and non-point sources of water pollution. 3. Recognize the impacts of various contaminants on water quality and human health. 4. Analyse the suitability of water for irrigation based on established criteria. 5. Explore water decontamination technologies and management practices for poor-quality water utilization.
Course Content	**Theory:** Natural factors affecting quality of surface water and groundwater, water quality objectives in relation to domestic, industrial and agricultural activities, drinking water quality standards, irrigation water quality classification as per USSL and All Indian Coordinated Research Project (AICRP) criteria, point and nonpoint water pollution sources, water contamination due to inorganic and organic compounds, water contamination related to agricultural chemicals, food industry, hydrocarbon and synthetic organic compounds. Arsenic and fluoride contamination in groundwater and remedial measures, water decontamination technologies, cultural and management practices for using poor quality water for irrigation. **Practical:** Water quality analysis and classification according to USSL and AICRP criteria; soil chemical analysis and estimation of lime and gypsum requirements; study of salinity development under shallow and deep water table conditions; study of contamination movement and transport in soil profile; study of different water decontamination techniques; study of different cultural and management practices for using poor quality water for irrigation; field visit to industrial effluent disposal sites.
References	• FAO. 1996. Control of water pollution from agriculture - FAO irrigation and drainage paper 55. • Gray, N.F. Water Technology. Raj Kamal Electric Press, Kundli, Haryana.

- Hussain, S.K. 1986. Text Book of Water Supply and Sanitary Engineering. Oxford & IBH Publishing Co. New Delhi.
- Manahan, S.E. 2009. Fundamentals of Environmental Chemistry. CRC Press, New York.
- McGauhey, P.H. 1968. Engineering Management of water quality. McGraw Hill Book Company, New York.
- Minhas, P.S. and Tyagi, N.K. 1998. Guidelines for irrigation with saline and alkali waters. Bull. No, 1/98, CSSRI, Karnal, p. :36.
- Punmia, B.C. and Lal, P.B.B. 1981. Irrigation and water power engineering. Standard Publishers Distributors, Delhi.

Course Outcomes

At the end of the course, learners will be able

CO1: Explain the natural factors affecting surface and groundwater quality and their significance.

CO2: Analyse water quality data and classify water for various uses based on established standards (USSL, AICRP).

CO3: Identify point and non-point sources of water pollution related to different activities and their environmental impacts.

CO4: Evaluate the effects of various contaminants (inorganic, organic, agricultural chemicals, industrial effluents) on water quality and human health.

CO5: Recommend and analyse the effectiveness of water decontamination technologies and management practices for using poor-quality water for irrigation.

Mapping between COs with POs and PSOs

Mapping between Cos, POs and PSOs

CO	PO												PSO		
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CO4															
CO5															

Course Code	**IDE-4.8.9**
Course Title	**Landscape Irrigation Design and Management**
Course Credit	**3(2+1)**

Objectives of Course

1. Understand the principles and methods of landscape irrigation design and management.
2. Compare and contrast conventional and modern irrigation systems for landscapes.
3. Design and install efficient landscape irrigation systems using appropriate components.
4. Operate and maintain landscape irrigation systems effectively.
5. Utilize automation technology for optimal irrigation control and water conservation.

Course Content

Theory: Conventional method of landscape irrigation- hose irrigation system, quick release coupling system and portable sprinkler with hose pipes; Modern methods of landscape irrigation- pop-up sprinklers, spray pop-up sprinkler, shrub adopter, drip irrigation and bubblers; Merits and demerits of conventional and modern irrigation systems, types of landscapes and suitability of different irrigation methods, water requirement for different landscapes, Segments of landscape irrigation systems, Main components of modern landscape irrigation systems and their selection criteria; Types of pipes, pressure ratings, sizing and

	selection criteria; Automation system for landscape irrigation- main components, types of controllers and their application, Design of modern landscape irrigation systems, operation and maintenance of landscape irrigation systems. **Practical:** Study of irrigation equipments for landscapes; Design and installation of irrigation system for landscape, determination of water requirement. Determination of power requirement, pump selection. Irrigation scheduling of landscapes, Study of irrigation controllers and other equipments, Use of AutoCAD in irrigation design: blocks & symbols, head layout, zoning and valves layout, pipe sizing, Pressure calculations etc., Visit to landscape irrigation system and its evaluation.
References	• Michael A.M. 2012. Irrigation: Theory and Practice. Vikas Publishing Vikas Publ. House New Delhi. • Singh Neeraj Partap. 2010. Landscape Irrigation and Floriculture Terminology, Bangalore. • Smith Stepehen W. Landscape Irrigation and Management. John Wiley and Sons.
Course Outcomes	At the end of the course, learners will be able **CO1**: Explain the advantages and disadvantages of conventional and modern landscape irrigation systems. **CO2**: Analyze water requirements for different landscapes and select appropriate irrigation methods based on terrain and plant needs. **CO3**: Design and install landscape irrigation systems, including selection and sizing of pipes, pumps, and other components. **CO4**: Implement and manage automation systems for landscape irrigation using various controllers and technologies. **CO5**: Conduct irrigation scheduling and maintain landscape irrigation systems for optimal performance and water conservation.

Mapping between Cos, POs and PSOs

CO	PO												PSO		
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Course Code	**REE -4.8.10**
Course Title	**Plastic Applications in Agriculture**
Course Credit	**3 (2+1)**
Objectives of Course	1. To understand the concept and importance of protected cultivation in modern agricultural practices. 2. To study different types of protected structures such as greenhouses, polyhouses, and shade net houses. 3. To describe the different types of materials used and design criteria for different types of protected cultivation structures. 4. To design, construction, and management of protected structures for optimal plant growth and yield.
Course Content	**Course Content:** Introduction of protected cultivation and plasticulture - types and quality of plastics used in soil and water conservation, production agriculture and post harvest management. Quality control measures. Present status and future prospective of plasticulture in India. Water management - use of plastics in in-situ

	moisture conservation and rain water harvesting. Plastic film lining in canal, pond and reservoir. Plastic pipes for irrigation water management, bore-well casing and subsurface drainage. Drip and sprinkler irrigation systems. Use of polymers in control of percolation losses in fields. Soil conditioning - soil solarisation, effects of different colour plastic mulching in surface covered cultivation. Nursery management - Use of plastics in nursery raising, nursery bags, trays etc. Controlled environmental cultivation - plastics as cladding material, green / poly / shade net houses, wind breaks, poly tunnels and crop covers. Plastic nets for crop protection - anti insect nets, bird protection nets. Plastic fencing. Plastics in drying, preservation, handling and storage of agricultural produce, innovative plastic packaging solutions for processed food products. Plastic cap covers for storage of food grains in open. Use of plastics as alternate material for manufacturing farm equipment and machinery. Plastics for aquacultural engineering and animal husbandry - animal shelters, vermi-beds and inland fisheries. Silage film technique for fodder preservation. Agencies involved in the promotion of plasticulture in agriculture at national and state level. Human resource development in plasticutlure applications. **Practical:**Design, estimation and laying of plastic films in lining of canal, reservoir and water harvesting ponds. Study of plastic components of drip and sprinkler irrigation systems, laying and flushing of laterals. Study of components of subsurface drainage system. Study of different colour plastic mulch laying. Design, estimation and installation of green, poly and shade net houses, low tunnels etc. Study on cap covers for food grain storage, innovative packaging solutions - leno bags, crates, bins, boxes, vacuum packing, unit packaging, CAS and MAP and estimation. Study on use of plastics in nursery, plant protection, inland fisheries, animal shelters, preparation of vermi-bed and silage film for fodder preservation. Study of plastic parts in making farm machinery. Visits to nearby manufacturing units/dealers of PVC pipes, drip and sprinkler irrigation systems, greenhouse/ polyhouse/shadehouse/ nethouse etc. Visits to farmers' fields with these installations.
References	1. Brahma Singh, Balraj Singh, Naved Sabir and Murtaza Hasan. 2014.Advances in Protected Cultivation. New India Publishing Agency, New Delhi. 2. Brown, R.P. 2004. Polymers in Agriculture and Horticulture. RAPRA Review Reports : Vol. 15, No. 2, RAPRA Technology Limited, U.K. 3. Central Pollution Control Board. 2012. Material on Plastic Waste Management. Parivesh Bhawan, East Arjun Nagar, Delhi-110032. 4. Charles A. Harper. 2006. Handbook of Plastics Technologies. The Complete Guide to Properties and Performance. McGraw-Hill, New Delhi. 5. Dubois. 1978. Plastics in Agriculture. Applied Science Publishers Limited, Essex, England. 6. Manas Chanda, Salil K. Roy. 2008. Plastics Fundamentals, Properties, and Testing. CRC Press. 7. Ojha,T.P. and Michael, A.M., 2012, Principles of Agricultural Engineering - I. Jain Brothers, Karol Bagh, New Delhi. 8. Pandey, P.H. 2014. Principles and Practices of Agricultural Structures and Environmental Control. Kalyani Publishers, Ludhiana, India. 9. Shankar, A.N. 2014. Integrated Horticulture Development in Eastern Himalayas, Plasticulture in AgriHorticulture Systems, 241-247. 10. Srivastava, R.K., R.C. Maheswari, T.P. Ojha, and A. Alam. 1988. Plastics in Agriculture. Jain Brothers, Karol Bagh, New Delhi.
Course Outcomes	At the end of the course, learners will be able **CO1:** To understand the concept and significance of protected cultivation and its role in sustainable agriculture. **CO2:** To get knowledge about green house technology, types of green houses and construction of green houses.

	CO3: To design and manage protected structures, including construction, environmental control, irrigation, and fertigation. **CO4:** To get knowledge of Green house equipments, materials of construction for traditional and low cost green houses. **CO5:** To learn about Irrigation systems used in greenhouses, shade net house in protected cultivation.

Mapping between Cos, POs and PSOs

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1															
CO2															
CO3															
CO4															

Course Code	**FMPE – 4.8.11**
Course Title	**Mechanics of Tillage and Traction**
Course Credit	**3(2+1)**
Objectives of Course	1) To get knowledge about mechanics of tillage tools. 2) To acquaintance with engineering properties of soil. 3)To learn about application of dimensional analysis in soil dynamics and traction prediction equation. 4) To familiarise with traction model and application of GIS in soil dynamics.
Course Content	**Theory:** Introduction to mechanics of tillage tools, engineering properties of soil, principles and concepts, stress strain relationship, design of tillage tools principles of soil cutting, design equation, force analysis, application of dimensional analysis in soil dynamics and traction prediction equation. Introduction to traction and mechanics, off road traction and mobility, traction model, traction improvement, tyre size, tyre lug geometry and their effects, tyre testing, soil compaction and plant growth, variability and application of GIS in soil dynamics. **Practical:** Measurement of static and dynamic soil parameters related to tillage, soil parameters related to puddling and floatation, draft for passive rotary and oscillating tools, slip and sinkage under dry and wet soil conditions and load and fuel consumption for different farm operations; Weight transfer and tractor loading including placement and traction aids; Studies on tyres, tracks and treads under different conditions, and soil compaction and number of operations.
References	• Vandenberg and Gill. Tillage and Traction. • Liljedahl JB and others. Tractor and Power Units. • Daniel Hill. Fundamentals of Soil Physics. • Terzaghi K & Peck Ralph B. Soil Mechanics in Engineering Practices.
Course Outcomes	At the end of the course, learners will be able **CO1**: Understand the mechanics of tillage tools. **CO2**: Design the tillage tools by using concept of soil mechanics. **CO3**: Able to use engineering properties of soil in design of tillage tools. **CO4**: Utilize the traction models and GIS applications in soil dynamics.

Mapping between Cos, POs and PSOs

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1															
CO2															
CO3															
CO4															

Course Code	**FMPE-4.8.12**
Course Title	**Farm Machinery Design and Production**
Course Credit	**3(2+1)**
Objectives of Course	1) To understand design parameters and design procedure of agricultural machines. 2) To get knowledge about standard procedures of design of various components of farm Machinery. 3) To acquaintance with CNC tools and manufacturing techniques including powder metallurgy, EDM etc. 4) To familiarise production technologies and economics of production.
Course Content	**Theory:** Introduction to design parameters of agricultural machines & design procedure. Characteristics of farm machinery design. Research and development aspects of farm machinery. Design of standard power transmission components used in agricultural machines: mechanical & hydraulic units. Introduction to safety in power transmission. Application of design principles to the systems of selected farm machines. Critical appraisal in production of Agricultural Machinery; Advances in material used for agricultural machinery. Cutting tools including CNC tools and finishing tools. Advanced manufacturing techniques including powder metallurgy, EDM (Electro Discharge Machining), Heat Treatment of steels including pack carburizing, shot pining process, etc. Limits, Fits & Tolerances, Jigs & Fixtures. Industrial lay-out planning, Quality production management. Reliability. Economics of process selection. Familiarization with Project Report. **Practical:** Familiarization with different design aspects of farm machinery and selected components. Solving design problems on farm machines & equipment Visit to Agricultural machinery manufacturing industry, Tractor manufacturing industry Jigs and Fixtures – study in relation to agricultural machinery. Fits, tolerances and limits; Layout planning of a small scale industry; Problems on Economics of process selection; Preparation of a project report; Case study for manufacturing of simple agricultural machinery.
References	• Richey, C.B. Agricultural Engineering Handbook. • Adinath M and AB Gupta. Manufacturing Technology. • Sharma PC and DK Aggarwal. Machine Design. Narula V. Manufacturing process. • Singh S. Mechanical Engineer's Handbook. • Chakrabarti NR. Data book for Machine Design.
Course Outcomes	At the end of the course, learners will be able **CO1:** Able to design agricultural machines according to modern design procedure and techniques. **CO2:** Able to design various components of farm Machinery using standard procedures of design. **CO3:** Become familiar with CNC tools and manufacturing techniques including powder metallurgy, EDM etc. **CO4:** Become capable to use production technologies and economics of production in production of farm Machinery.

Mapping between Cos, POs and PSOs

CO	**PO**												**PSO**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1															
CO2															
CO3															
CO4															

Course Code	**FMPE-4.8.13**

Course Title	Human Engineering and Safety
Course Credit	3 (2 + 1)
Objectives of Course	1) To get knowledge about human factors in human performance. 2) To understand the concept of biomechanics of human body part motion. 3) To acquaintance with Anthropometry. 4) To get familiarise regarding dangerous machine (Regulation) act and use of safety gadgets.
Course Content	**Theory** Human factors in system development – concept of systems; basic processes in system development, performance reliability, human performance. Information input process, visual displays, major types and use of displays, auditory and factual displays. Speech communications. Biomechanics of motion, types of movements, Range of movements, strength and endurance, speed and accuracy, human control of systems. Human motor activities, controls, tools and related devices. Anthropometry: arrangement and utilization of work space, atmospheric conditions, heat exchange process and performance, air pollution. Dangerous machine (Regulation) act, Rehabilitation and compensation to accident victims, Safety gadgets for spraying, threshing, Chaff cutting and tractor & trailer operation etc. **Practical** Calibration of the subject in the laboratory using bi-cycle ergo-meter. Study and calibration of the subject in the laboratory using mechanical treadmill; Use of respiration gas meter from human energy point of view. Use of Heart Rate Monitor. Study of general fatigue of the subject using Blink ratio method, Familiarization with electro-myograph equipment, anthropometric measurements of a selected subjects. Optimum work space layout and locations of controls for different tractors. Familiarization with the noise and vibration equipment. Familiarization with safety gadgets for various farm machines.
References	**Reference Books** • Chapanis A. 1996. Human Factors in System Engineering. John Wiley & Sons, New York. • Dul J. and Weerdmeester B.1993. Ergonomics for Beginners. A Quick Reference Guide. Taylor and Francis, London. • Mathews J. and Knight A. A. 1971. Ergonomics in Agricultural Equipment Design. National Institute of Agricultural Engineering. • Astrand P. And and Rodahl K. 1977. Textbook of Work Physiology. Mc Hill Corporation, New York. • Mark S. Sanders and Ernest James McCormick. 1993. Human Factors in Engineering and Design. Mc Hill Corporation, New York. • Keegan J J, Radke AO. 1964. Designing vehicle seats for greater comfort. SAE Journal; 72:50~5. • Yadav R, Tewari V.K. 1998. Tractor operator workplace design-a review. Journal of Terra mechanics 35: 41-53.
Course Outcomes	At the end of the course, learners will be able **CO1**: Use human factors in design of farm machinery. **CO2**:Able to design work space by using man-machine-environmental factors and anthropometric principles. **CO3**: Know the dangerous machine (Regulation) act and use of safety gadgets during working with farm machineries.

Mapping between Cos, POs and PSOs

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1															
CO2															
CO3															

Course Code	FMPE-4.8.14
Course Title	Tractor Design and Testing

Course Credit	**3 (2 + 1)**
Objectives of Course	1) To understand design Procedure for design and development of agricultural tractor. 2) To get knowledge about tractor stability & weight distribution. 3) To get knowledge about design of various systems of tractor. 4) To familiarise tractor testing.
Course Content	**Theory** Procedure for design and development of agricultural tractor, Study of parameters for balanced design of tractor for stability & weight distribution, traction theory, hydraulic lift and hitch system design. Design of mechanical power transmission in agricultural tractors: single disc, multi disc and cone clutches. Rolling friction and anti-friction bearings. Design of Ackerman Steering and tractor hydraulic steering. Study of special design features of tractor engines and their selection viz. cylinder, piston, piston pin, crankshaft, etc. Design of seat and controls of an agricultural tractor. Tractor Testing. **Practical** Design problem of tractor clutch – (Single/ Multiple disc clutch). Design of gear box (synchromesh/constant mesh), variable speed constant mesh drive; Selection of tractor tires – Problem solving. Problem on design of governor. Design and selection of hydraulic pump. Engine testing as per BIS code. Drawbar performance in the lab; PTO test and measure the tractor power in the lab/field; Determining the turning space, turning radius and brake test, hydraulic pump performance test and air cleaner and noise measurement test; Visit to tractor testing centre/industry.
References	**Reference Books** • Liljedahl J B & Others. Tractors and Their Power Units. • Raymond N, EA Yong and S Nicolas. Vehicle Traction Mechanics. • Maleev VL. Internal Combustion Engines. • Kirpal Singh. Automobile Engineering – Vol I and Vol II. • Richey C.B. Agricultural Engineering Handbook. • Mehta ML, SR Verma, SK Mishra, VK Sharma. Testing & Evaluation of Agricultural Machinery.
Course Outcomes	At the end of the course, learners will be able **CO1**: Use standard design procedure for design and development of agricultural tractor. **CO2**: Utilize the concept of stability & weight distribution in tractor design. **CO3**: Design various systems of tractor. **CO4**: Become familiar with procedure of tractor testing.

Mapping between Cos, POs and PSOs

CO	**PO**												**PSO**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1															
CO2															
CO3															
CO4															

Course Code	**FMPE-4.8.15**
Course Title	**Hydraulic Drives and Controls**
Course Credit	**3 (2 + 1)**
Objectives of Course	1) To understand Hydraulic Basics laws. 2) To get knowledge about different hydraulic components. 3) To get knowledge about design, types and use of pumps and valves in hydraulic system. 4) To familiarise with use of pneumatics systems, Robotics systems in agricultural application.
Course Content	**Theory** Hydraulic Basics: Pascal's Law, Flow, Energy, Work, and Power. Hydraulic Systems, Color Coding, Reservoirs, Strainers and Filters, Filtering Material and Elements. Accumulators, Pressure Gauges and Volume Meters, Hydraulic Circuit, Fittings and Connectors. Pumps, Pump Classifications, operation, performance, Displacement, Design ofGear Pumps, Vane Pumps, Piston Pumps. Hydraulic Actuators,Cylinders, Construction and Applications, Maintenance, Hydraulic Motors. Valves, Pressure-Control Valves, Directional- Control Valves, Flow-Control Valves, Valve. Installation, Valve Failures and Remedies, Valve Assembly, Troubleshooting of Valves Hydraulic Circuit Diagrams and Troubleshooting, United States of American Standards Institute USASI Graphical Symbols Tractor hydraulics, nudging system, ADDC. Pneumatics: Air services, logic units, Fail safe and safety systems Robotics: Application of Hydraulics and Pneumatics drives in agricultural systems, Programmable Logic Controls (PLCs). **Practical** Introduction to hydraulic systems. Study of hydraulic pumps, hydraulic actuators. Study of hydraulic motors, hydraulic valves, colour codes and circuits. Building simple hydraulic circuits, hydraulics in tractors. Introduction to pneumatics, pneumatics devices, pneumatics in agriculture; Use of hydraulics and pneumatics for robotics.
References	**Reference Books** • Kepner RA, Roy Barger & EL Barger. Principles of Farm Machinery. • Anthony E. Fluid Power and Applications. • Majumdar. Oil Hydraulic System. • Merit. Hydraulic Control Systems. • John Deere. Fundamentals of Service Hydraulics.
Course Outcomes	At the end of the course, learners will be able **CO1**: Use Hydraulic laws in hydraulic system design. **CO2**: Able to recognise different hydraulic components. **CO3**: Utilise various types of pumps and valves in hydraulic system. **CO4**: Become familiar f with use of pneumatics systems, Robotics systems in agricultural application.

Mapping between Cos, POs and PSOs

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1															
CO2															
CO3															
CO4															

Course Code	**FMPE-4.8.16**
Course Title	**Precision Agriculture and System Management**
Course Credit	**3(2+1)**

Objectives of Course	1) To understand concept of Precision Agriculture. 2) To get knowledge about equipment used for precision agriculture. 3) To get knowledge about GIS and sensors based precision agriculture machinery. 4) To familiarise with use of Database and System approach in farm machinery management.
Course Content	**Theory:** Precision Agriculture – need and functional requirements. Familiarization with issues relating to natural resources. Familiarization with equipment for precision agriculture including sowing and planting machines, power sprayers, land clearing machines, laser guided land levellers, straw-chopper, straw-balers, grain combines, etc. Introduction to GIS based precision agriculture and its applications. Introduction to sensors and application of sensors for data generation. Database management. System concept. System approach in farm machinery management, problems on machinery selection, maintenance and scheduling of operations. Application to PERT and CPM for machinery system management. **Practical:** Familiarization with precision agriculture problems and issues. Familiarization with various machines for resource conservation. Solving problems related to various capacities, pattern efficiency, system limitation, etc. Problems related to cost analysis and inflation and problems related to selection of equipment, replacement, breakeven analysis, time value of money etc.
References	• Kuhar J E. The Precision Farming Guide for Agriculturist. • Dutta SK. Soil Conservation and land management. • Sigma and Jagmohan. Earth Moving Machinery. • Wood and Stuart. Earth Moving Machinery. • DeMess MN. Fundamentals of Geographic Information System. • Hunt Donnell. Farm Power and Machinery Management. • Sharma DN and S Mukesh. Farm Power and Machinery Management Vol I.
Course Outcomes	At the end of the course, learners will be able **CO1**: Understand concept of Precision Agriculture. **CO2**: Understand the importance of precision agriculture equipments. **CO3**: Utilise the concept of GIS and sensors in development of precision agriculture machinery. **CO4**: Familiar to use Database and System approach in farm machinery management.

Mapping between Cos, POs and PSOs

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1															
CO2															
CO3															
CO4															

Course Code	PFE-4.8.17
Course Title	**Food quality and control**
Course Credit	3 (2 + 1)
Objectives of Course	1. To impart knowledge on food quality aspect. 2. To understand the concept of colour, flavour, sampling, viscosity, texture etc. 3. To understand various quality control tools used in food industries. 4. To become aware the food standards and understand the concept of TQM and TQC
Course Content	**Theory:** Basics of Food Science and Food Analysis, Concept, objectives and need of food quality. Measurement of colour, flavour, consistency, viscosity, texture and their relationship with food quality and composition. Sampling; purpose, sampling techniques, sampling procedures for liquid, powdered and granular materials,

	Quality control, Quality control tools, Statistical quality control, Sensory evaluation methods, panel selection methods, Interpretation of sensory results. Instrumental method for testing quality. Food adulteration and food safety. TQM and TQC, consumer p**References** and acceptance, Food Safety Management Systems GAP, GHP, GMP, Hazards and HACCP (Hazard analysis and critical control point), Sanitation in food industry (SSOP), Food Laws and Regulations in India, FSSAI, Food grades and standards BIS, AGMARK, PFA, FPO, ISO 9000, 22000 Series. CAC (Codex Alimantarious Commission), Traceability and Quality Assurance system in a process plant, Bio safety and Bioterrorism. **Practical:** Examination of cereals & pulses from one of go-downs and market shops in relation to FPO and BIS specifications, Detection of adulteration and examination of ghee for various standards of AGMARK & BIS standards, Detection of adulteration and examination of spices for AGMARK and BIS standards, Detection of adulteration and examination of milk and milk products for BIS standards, Detection of adulteration and examination of fruit products such as jams, jellys, marmalades for FPO specification, Visit to quality control laboratory, Case study of statistical process control in food processing industry, Study of registration process and licensing procedure under FSSAI, Study of sampling techniques from food processing establishments, Visit to food processing laboratory and study of records and reports maintained by food processing laboratory.
References	• Ranganna S. Hand book of Analysis and Quality Control for Fruit and Vegetable Products. • Srilakshmi B, Food Science. • Sharma Avanthi. A text book of Food Science and Technology. • Mudambi Sumati R, Rao Shalini M and Rajagopal M.V. Food Science. • Potter NN and Hotchkiss JH, Food Science. • Dev Raj, Rakesh Sharma and Joshi V.K, Quality for Value Addition in Food Processing. • The Food Safety and Standards Act along with Rules & Regulations. Commercial Law Publishers (India) Pvt. Ltd.
Course Outcomes	At the end of the course, learners will be able **CO1**: To acquaint the students with various aspects of food quality. **CO2:** To acquaint the students with various laws controlling the adulteration and examination the food. **CO3:** To understand basic tools involved in food quality in total quality management. **CO4:** To understand the concept of total quality management.

Mapping between Cos, POs and PSOs

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1															
CO2															
CO3															
CO4															

Course Code	PFE-4.8.18
Course Title	Food Plant Design and Management
Course Credit	3 (2+1)
Objectives of Course	1. The student will be able to learn about preparation of project report and study of different types of records relating to production of a food plant. 2. Study of different types of records relating to finance in a food plant. 3. Study of different types of records relating to marketing of a food business, Brain storming and SWOT analysis to start a food processing business.
Course Content	Food plant location, selection criteria, Selection of processes, plant capacity, Requirements of plant building and its components, Project design, flow diagrams, selection of equipment, process and controls, Objectives and principles of food plant layout. Salient features of processing plants for cereals, pulses, oilseeds, horticultural and vegetable crops, poultry, fish and meat products, milk and milk products. Introduction to Finance, Food Product Marketing, Food Business Analysis and Strategic Planning, Introduction to Marketing, Food Marketing Management, Supply chain management for retail food products, Entrepreneurship development in food industry, SWOT analysis, generation, incubation and commercialization of ideas and innovations, New product development process, Government schemes and incentive for promotion of entrepreneurship, Govt. policy on small and medium scale food processing enterprise, export and import policies relevant to food processing sector, procedure of obtaining license and registration under FSSAI, Cost analysis and preparation of feasibility report.
References	• Hall, H.S. and Rosen, Y.S. Milk Plant Layout. FAO Publication, Rome. • López Antonio. Gómez. Food Plant Design. • Robberts Theunis C. Food plant engineering systems by, CRC Press, Washington. • Maroulis Z B and Saravacos G D. Food plant economics. Taylor and Francis, LLC • Mahajan M. Operations Research. Dhanpat Rai and Company Private Limited, Delhi • Maroulis Z B. Food Process Design. Marcel Dekker, Inc ,Cimarron Road, Monticello, New York 12701, USA.
Course Outcomes	At the end of the course, learners will be able **CO1:** Explain the parameters to be considered in a food plant layout. **CO2:** Compare different food processing plants layouts. **CO3:** Design specifications of food processing plant and estimate the cost of plant set up and operation. **CO4:** Design the machinery required in process control of the food processing plant. **CO5:** Explain sanitation procedures used in the food processing plant and report making.

Mapping between Cos, POs and PSOs

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1															
CO2															
CO3															
CO4															
CO5															

Course Code	**PFE-4.8.19**
Course Title	**Food Packaging Technology**
Course Credit	3 (2 + 1)
Objectives of Course	1. To provide knowledge on spoilage of food materials, various packaging systems, different packaging materials and their properties 2. To acquaint knowledge about various testing of packaging materials and their packaging equipments. 3. To acquaint knowledge about advanced packaging techniques used in food industry. 4. To enable the students to acquire skills and to understand the packaging technology
Course Content	Factors affecting shelf life of food material during storage, Interactions of spoilage agents with environmental factors as water, oxygen, light, pH, etc. and general principles of control of the spoilage agents; Difference between food infection, food intoxication and allergy. Packaging of foods, requirement, importance and scope, frame work of packaging strategy, environmental considerations, Packaging systems, types: flexible and rigid; retail and bulk; levels of packaging; special solutions and packaging machines, technical packaging systems and data management packaging systems, Different types of packaging materials, their key properties and applications, Metal cans, manufacture of two piece and three piece cans, Plastic packaging, different types of polymers used in food packaging and their barrier properties. manufacture of plastic packaging materials, profile extrusion, blown film/ sheet extrusion, blow molding, extrusion blow molding, injection blow molding, stretch blow molding, injection molding. Glass containers, types of glass used in food packaging, manufacture of glass and glass containers, closures for glass containers. Paper and paper board packaging, paper and paper board manufacture process, modification of barrier properties and characteristics of paper/ boards. Relative advantages and disadvantages of different packaging materials; effect of these materials on packed commodities. Nutritional labelling on packages, CAS and MAP, shrink and cling packaging, vacuum and gas packaging; Active packaging, Smart packaging, Packaging requirement for raw and processed foods, and their selection of packaging materials, Factors affecting the choice of packaging materials, Disposal and recycle of packaging waste, Printing and labelling, Lamination, Package testing: Testing methods for flexible materials, rigid materials and semi rigid materials; Tests for paper (thickness, bursting strength, breaking length, stiffness, tear resistance, folding endurance, ply bond test, surface oil absorption test, etc.), plastic film and laminates (thickness, tensile strength, gloss, haze, burning test to identify polymer, etc.), aluminium foil (thickness, pin holes, etc.), glass containers (visual defects, colour, dimensions, impact strength, etc.), metal containers (pressure test, product compatibility, etc.).
References	• Coles, R., McDowell, D., Kirwan, M .J. 2003. Food Packaging Technology. Blackwell Publishing Co. • Gosby, N.T. 2001. Food Packaging Materials. Applied Science Publication • John, P.J. 2008. A Handbook on Food Packaging Narendra Publishing House, • Mahadevia, M., Gowramma, R.V. 2007. Food Packaging Materials. Tata McGraw Hill • Robertson, G. L. 2001. Food Packaging and Shelf life: A Practical Guide. Narendra Publishing House. • Robertson, G. L. 2005. Food Packaging: Principles and Practice. Second Edition. Taylor and Francis Pub.
Course Outcomes	At the end of the course, learners will be able **CO1**: To acquaint the students with various food packaging materials, **CO2:** To acquaint the students with various aspects of advanced packaging methods and technology.

	CO3: To acquaint the students about testing of packaging materials and their packaging equipments. CO4: To strength industry-institute linkage with leading institutes for promoting entrepreneurship among students.

Mapping between Cos, POs and PSOs

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1															
CO2															
CO3															
CO4															

Course Code	**PFE-4.8.20**
Course Title	**Development of Processed Products**
Course Credit	3 (2 + 1)
Objectives of Course	1. To provide conceptual knowledge about the mass and energy balance used in food processing operations 2. To acquire knowledge about technology of various value-added food products. 3. To acquaint students with the process technology involved in extruded products fruit juice and candy manufacturing. 4. To enable the students to understand the recent trends in food processing e.g. cryogenic grinding, critical fluid extraction etc.
Course Content	**Theory:** Process design, Process flow chart with mass and energy balance, Water activity, Unit operations and equipments for processing, New product development, Technology for value added products from cereal, pulses and oil seeds, Milling, puffing, flaking, Roasting, Bakery products, snack food. Extruded products, oil extraction and refining, Technology for value added products from fruits, vegetables and spices, Canned foods, Frozen foods, dried and fried foods, Fruit juices, Sauce, Sugar based confection, Candy, Fermented food product, Cryogenic grinding and critical fluid extraction technology, Technology for animal produce processing , meat, poultry, fish, egg products, Health food, Nutra-ceuticals and functional food, Organic food. **Practical:** Process design and process flow chart preparation, preparation of different value added products, Visit to roller wheat flour milling, rice milling, spice grinding mill, milk plant, dal and oil mill, fruit/vegetable processing plants & study of operations and machinery, Process flow diagram and study of various models of the machines used in a sugar mill.
References	• Geankoplis C. J. Transport processes and unit operations, Prentice-Hall. • Rao, D. G. Fundamentals of Food Engineering PHI Learning Pvt. Ltd, New Delhi. • Norman N. Potter and Joseph H. Hotchikss. Food Science. Chapman and Hall Pub. • Acharya, K T Everyday Indian Processed foods. National Book Trust. • Mudambi Sumati R., Shalini M. Rao and M V Rajgopal. Food Science. New Age International Publishers. • Negi H.P.S., Savita Sharma, K. S. Sekhon. Hand book of Cereal technology. Kalyani Pub. • K. P. Sudheer, V. Indira 2007. Post-Harvest Technology of Horticultural Crops, New India Publishing
Course Outcomes	At the end of the course, learners will be able **CO1**: To acquaint the students with various value-added food products. **CO2:** To acquaint the students with various aspects of food processing technology. **CO3:** To acquaint the students about advanced food processing technologies.

	CO4: To study the flow charts and understand the different food processing techniques.

Mapping between COs with POs and PSOs

Please refer mapping of PO and PSO for the style of mapping.

Mapping between Cos, POs and PSOs

CO	**PO**												**PSO**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1															
CO2															
CO3															
CO4															

Course Code	**PFE-4.8.21**
Course Title	**Process Equipment Design**
Course Credit	3 (2 + 1)
Objectives of Course	1. To provide introductory knowledge about the process equipment design 2. To acquire knowledge material selection. 3. To acquaint students with design of various food processing equipment e.g. heat exchangers, elevators etc. 4. To enable the students to preparing computer added designs.
Course Content	**Theory:** Introduction on process equipment design, Application of design engineering for processing equipments, Design parameters and general design procedure, Material specification, Types of material for process equipments, Design codes, Pressure vessel design, Design of cleaners. Design of tubular heat exchanger, shell and tube heat exchanger and plate heat exchanger, Design of belt conveyer, screw conveyer and bucket elevator, Design of dryers. Design of milling equipments. Optimization of design with respect to process efficiency, energy and cost, Computer Aided Design. **Practical:** Design of pressure vessel, cleaners, milling equipments, tubular heat exchanger, shell and tube type heat exchanger, plate heat exchanger, dryer, belt conveyor, bucket elevator, screw conveyor.
References	• Mahajani, V. V. and Umarji, S. B., Joshi's Process equipment design, Macmillan. • Bhattacharyya, B. C., Introduction to Chemical Equipment design, CBS Publishers and Distributors. • Geankoplis C. J. Transport processes and unit operations, Prentice-Hall. • Rao, D. G. Fundamentals of Food Engineering PHI Learning Pvt. Ltd, New Delhi.
Course Outcomes	At the end of the course, learners will be able **CO1:** To acquaint the students with principles of process equipment design for development of process equipment. **CO2:** To acquaint the students about various design codes. **CO3:** To design various food production processes. **CO4:** To learn CAD the different food processing techniques.

Mapping between Cos, POs and PSOs

CO	**PO**												**PSO**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1															
CO2															
CO3															
CO4															

Course Code	**REE -4.8.22**
Course Title	**Photovoltaic Technology and Systems**
Course Credit	**3 (2+1)**
Objectives of Course	1. To develop a comprehensive technological understanding in solar PV system components. 2. To understand physical theories and phenomena of solar cell with inclusion of semiconductor physics. 3. To discuss different aspects of solar photovoltaic technologies for applications in building integrated PV, standalone system and power plant system. 4. To provide in-depth understanding of design parameters to help design and simulate the performance of a solar PV power plant. 5. To pertain knowledge about planning, project implementation and operation of solar PV power generation.
Course Content	**Theory:** Solar PV Technology: Advantages, Limitations, Current Status of PV technology, SWOT analysis of PV technology. Types of Solar Cell, Wafer based Silicon Cell, Thin film amorphous silicon cell Thin Cadmium Telluride (CdTe) Cell, Copper Indium Gallium Selenide (CiGS) Cell, Thin film crystalline silicon solar cell. Solar Photo Voltaic Module: Solar cell, solar module, solar array, series & parallel connections of cell, mismatch in cell, fill factor, effect of solar radiation and temperature on power output of module, I-V and power curve of module. Balance of Solar PV system: Introduction to batteries, battery classification, lead acid battery, Nicked Cadmium battery, comparison of batteries, battery parameters, Charge controller: types of charge controller, function of charge controller, PWM type, MPPT type charge controller, Converters: DC to DC converter and DC to AC type converter. Application of Solar PV system. Solar home lighting system, solar lantern, solar fencing, solar street light, solar water pumping system, Roof top solar photovoltaic power plant and smart grid. **Practicals:** 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.
References	1. British BioGen. 1997, Anaerobic digestion of farm and food processing practices- Good practice guidelines, London, available on www.britishbiogen.co.UK. 2. Butler, S. 2005. Renewable Energy Academy: Training wood energy professionals. 3. Centre for biomass energy. 1998. Straw for energy production; Technology- Environment- Ecology. Available: 4. www.ens.dk. 5. Solar photovoltaic - fundamentals, technologies and applications, third edition by solanki, chetan singh ISBN: 978-81-203-5111-0**.**
Course Outcomes	At the end of the course, learners will be able **CO1.** To understand the physical principles of the photovoltaic (PV) solar cell and what are its sources of losses **CO2.** To know the electrical (current-voltage and power-voltage) characteristics of solar cell, panel or generator and how the environment parameters influence it **CO3.** To know the most important characteristics of the elements within a PV system, battery and charge controller, DC/DC converter, DC/AC converter (inverter) and loads **CO4.** To understand the role of solar energy in the context of regional and global energy system, its economic, social and environmental implications, and the impact of technology on a local and global context

	CO5. To know the main lines of research in the field of photovoltaic technology and solar energy.

Mapping between Cos, POs and PSOs

CO	PO												PSO		
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CO4															
CO5															

Course Code	**REE -4.8.23**
Course Title	**Waste and By-Products Utilization**
Course Credit	**3 (2+1)**
Objectives of Course	1.To assess the activities involved for the proposed and determine the type, its characteristics, nature and estimated volumes of waste to be generated. 2.To identify potential environmental impacts from the generation of waste. 3.To design appropriate waste handling and an appropriate technology for energy generation. 4.To enable students to understand of the concept of waste to energy. 5.To learn about the best available technologies for waste to energy. 6.To link legal, technical & management principles for production of energy from waste.
Course Content	**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, Temperature, pH, Oxygen demands (BOD, COD), fat, oil and grease content, metal content, forms of phosphorous and sulphur in waste waters, microbiology of waste, other ingredients like insecticide, pesticides and fungicides residues, Waste utilization in various industries, furnaces and boilers run on agricultural wastes and byproducts, briquetting of biomass as fuel, production of charcoal briquette, generation of electricity using surplus biomass, producer gas generation and utilization, Waste treatment and disposal, design, construction, operation and management of institutional community and family size biogas plants, concept of vermin-composting, Pre-treatment of waste: sedimentation, coagulation, flocculation and floatation, Secondary treatments: Biological and chemical oxygen demand for different food plant waste– trickling filters, oxidation ditches, activated sludge process, rotating biological contractors, lagoons, Tertiary treatments: Advanced waste water treatment process-sand, coal and activated carbon filters , phosphorous, sulphur, nitrogen and heavy metals removal, Assessment, treatment and disposal of solid waste; and biogas generation, Effluent treatment plants, Environmental performance of food industry to comply with ISO-14001 standards. **Practicals:** 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.
References	1. Markel, I.A. 1981. Managing Livestock Waste, AVI Publishing Co.

2. Pantastico, ECB. 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. V.K. Joshi & S.K. Sharma. Food Processing Waste Management: Treatment & Utilization. New India Publishing Agency.
7. Vasso Oreopoulou and Winfried Russ (Edited). 2007. Utilization of By-products and Treatment of waste in the Food Industry. Springer Science & Business media, LLC 233 New York.
8. Prashar, Anupama and Bansal, Pratibha. 2007-08. 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.

Course Outcomes

At the end of the course, learners will be able

CO1: To characterize different biomass feedstocks based on its constituents and properties

CO2: To understand and evaluate various biomass pretreatment and processing techniques in terms of their applicability for different biomass type for biomass conversion processes

CO3: To understand the process of combustion, pyrolysis, gasification and liquefaction for production of value added bio-products, biogas, bio-CNG generation etc.

CO4: To understand basics of biofuels, their production technologies and applications in various energy utility routes.

Mapping between Cos, POs and PSOs

CO	PO												PSO		
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CO2															
CO3															
CO4															

Course code	**CSE-4.8.24**
Course title	**Artificial Intelligence**
Corse credit	3(3+0)
Objective of Course	1. To learn the fundamental concepts of Artificial Intelligence (AI) systems. 2. To learn various AI techniques such as expert systems, fuzzy logic, neural network and genetic algorithms and their applications. 3. To get awareness regarding various application areas in the field of AI. 4. To enable student to do simple exercises of AI
Course Content	Theory: Foundation and history of artificial intelligent, problems and techniques – AI programming languages, introduction to LISP and PROLOG- problem spaces and searches, blind search strategies, Breadth first- Depth first- heuristic search techniques Hill climbing: best first-A* algorithm AO* algorithm- game tree, Min max algorithms, game playing- alpha beta pruning. Knowledge representation issues, predicate logic- logic programming, semantic nets- frames and inheritance, constraint propagation, representing knowledge using rules, rules based deduction systems. Reasoning under uncertainty, review of probability, Baye's probabilistic interferences and Dempster shafer theory, Heuristic methods, symbolic reasoning under uncertainty, Statistical reasoning, Fuzzy reasoning, Temporal reasoning, Non monotonic reasoning. Planning and planning in situational calculus, representation for planning, partial order planning algorithm, learning from examples, discovery as learning, learning by analogy, explanation based learning, neural nets, genetic algorithms. Principles of Natural language processing, rule based systems architecture, Expert systems, knowledge acquisition concepts, AI application to robotics, and current trends in intelligent systems.
References:	▪ Russell, S. and P. Norvig. 1998. Artificial Intelligence: A Modern Approach. Prentice Hall. ▪ Rich, Elain and Kevin Knight. 1991. Artificial Intelligence. TMH. ▪ Patrick Henry Winston. 1992. Artificial intelligence. Addition Wesley 3rd Ed. ▪ Nilson Nils J. Principles of Artificial Intelligence. Norsa Publishing House.
Course Outcomes	At the end of the course, learners will be able **CO1**: Understanding of fundamental concepts related to artificial intelligence. **CO2**: Understanding of the various AI techniques. **CO3**: Understanding of the applications of artificial intelligence in various domains. **CO4**: Develop a simple AI application.

Mapping between Cos, POs and PSOs

CO	**PO**												**PSO**		
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CO3															
CO4															

Course Code	**ME-4.8.25**
Course Title	**Mechatronics**
Course Credit	**3 (2+1)**

Objectives of Course

Objective

1. To acquaint and equip the students with important terminologies of mechatronics
2. To acquaint and equip with knowledge of sensors, interface and control
3. To introduce concepts of Mathematical Models, Engineering Systems
4. To introduce application of mechatronics, automation in agriculture

Course Content

Theory

Definition of mechatronics, measurement system, control systems, microprocessor based controllers, mechatronics approach. Sensors and transducers, performance terminology, Displacement, Position & amp; Proximity Sensors, photo-electric transducers, flow transducers, optical sensors and transducers. Actuators, Mechanical Actuation Systems, Hydraulic & Pneumatic Actuation Systems, Electrical Actuation

Systems, A.C. Motor, D.C. Motor, Stepper Motor. Signal conditioning process, filtering digital signal, multiplexers, data acquisition, digital signal processing, measurement system, pulse modulation, data presentation systems. System modelling & control, Mathematical Models, Engineering Systems, Electro-mechanical & Hydraulic-mechanical Systems, Modelling Dynamic Systems, Transfer Functions, Control Modes, PID Controller. Micro-processor & computer, Computer and Interfacing, Micro-computer Structure, Micro-controllers, Application of Microcontrollers, PLC. Robotics, Robot components, robot classification and specification, Work envelopes, other basic parameters of robots. Robot applications, Robot applications in manufacturing, Material transfer and machine loading/unloading, Processing operations like Welding & Painting, Assembly operations, Inspection automation, Future applications.

Practical

Selection of sensor for a particular application from Catalogue/Internet. Design a mechatronics product/system and incorporate application of mechatronics for enhancing product values. To study the hardware and software of mechatronics kit. To move a table in X-direction within the range of proximity sensors using Control-X software. To run a motor with PLC. To run a conveyor with computer. To study the movement of actuating cylinders and sensors.

References

Bolton, W. Mechatronics. Pearson Education Asia.
Wolfram, Stadler. Analytical Robotics and Mechatronics. Mc-Graw Hill.
Doeblin E.O. Measurement Systems. Mc-Graw Hill.
Mahind, A.P. Introduction to Digital Computer Electronics. TMH.
Niku, S.Y. Introduction to Robotics: Analysis, systems and applications", Pearson Education Asia. Craig, J.J.
Introduction to Robotics. Pearson Education Asia.

Course Outcomes

At the end of the course, learners will be able.

CO1: Ability to understand mechatronics.
CO2: To understand on concepts of sensors & controls.
CO3: Apply, execute and control automation in agriculture machines.
CO4: Ability to use robotic machinery in agriculture.

Mapping between Cos, POs and PSOs

CO	PO												PSO		
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CO1															
CO2															
CO3															
CO4															

Course Code	**REE -4.8.26**
Course Title	**Energy Conservation and Audit in Agricultural Industry**
Course Credit	**3 (2+1)**
Objectives of Course	1. To understand the energy management, conservation processes, principles of energy auditing, energy flow diagram, economics of energy conservation opportunities. 2. To understand the energy management information systems, various key features of Energy Conservation Act and ECBC. 3. To understand the scope for energy conservation in electrical and thermal energy utilities.
Course Content	**Theory:** General energy problem, Energy consumption in Agriculture Sector and other sectors, demand supply gap, Scope for energy conservation and its benefits, Energy conservation Principle-Maximum energy efficiency, Maximum cost effectiveness, Features of EC act Standards and labeling, designated consumers, Energy conservation Building codes (ECBC), Energy management concept and objectives, Initialing planning, Leading controlling, Promoting, Monitoring and reporting, Energy management programmes, Energy saving opportunities in electric motors, benefits of power factor improvement and its techniques-shunt capacitor, synchronous condenser etc, effects of harmonics on motors and remedies leading to energy conservation, energy conservation by VSD, Energy conservation in electric furnaces, ovens and boilers, lighting techniques- Natural, CFL, LED lighting sources and fittings,New Equipment technology, staffing , training, calculation and costing of energy conservation project, Depreciation, cost, sinking fund method cost evaluation by return on Investment (ROI) and pay back method etc, Risk analysis, case analysis, Performance improvement of existing power plant, cogeneration, small hydro, DG set, Demand side management, load response programmes; Types of tariff and restructuring of electric tariff Technical measures to optimize T and D losses, Energy audit and its benefits, Energy flow diagram Preliminary, Detailed energy audit. Methodology of -preliminary energy audit and Detailed energy audit –Phase I, Pre audit, Phase II- Audit and Phase III- Post audit, Energy audit report, Electrical Measuring Instruments - Power Analyser. Combustion analyzer, fuel efficiency monitor, thermometer-contact, infrared, pitot tube and manometer, water flowmeter, leak detector, tachometer and luxmeter, IE rules and regulations for energy audit Electricity act(Numerical). **Practical: CASE STUDY OF AGRO INDUSRY FOR THE FOLLOWING SUB STUDIES:** List various energy management systems prevailing in a Agro industry/Organization; Identify the energy management skills and strategies in the energy management system; Organize a energy management programme in a given industry; List the various energy conservation methods useful in a particular industry; Identify the critical areas where energy conservation is required; Select appropriate energy conservation method for the critical area identified; List the various energy conservation methods useful in power generation, transmission and distribution; Find out the payback period for a given energy conservation equipment; Determine depreciation cost of a given energy conservation project/equipment; Draw the energy flow diagram for a industry/shop floor division; Identify various measuring instruments used for energy audit; Use various measuring instruments for carrying out energy audit; Prepare a sample energy audit questionnaire; Prepare a energy audit report; Prepare a technical report on energy conservation act 2003; Prepare a technical report on ECBC 2.
References	1.Electric Energy Generation, Utilisation and Conservation. Sivaganaraju, S Pearson, New Delhi, 2012

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<tr><td></td><td>2.Electrical Power V. K. Mehta Khanna and Khanna Publishers, New Dehli
3.Electrical Power S. L. Uppal Khanna and Khanna Publishers, New Dehli
4.Art and Science of utilization of Electrical Energy H. Partab Dhanapat Rai and Sons, New Dehli
5.Prasanna Chandra Project Management Tata Mcgraw Hill, New Delhi
6.Prasanna Chandra Financial Management Tata Mcgraw Hill, New Delh
7.Wayne C. Turner Energy Management Handbook –
8.Paul O Callaghan Energy management Mcgraw Hill, New Delhi
9.www.bee-india.com Fundamentals of electrical system Bureau of Energy Efficiency</td></tr>
<tr><td>Course Outcomes</td><td>At the end of the course, learners will be able
CO1: To understand the current energy scenario along with energy management and strategies and to take action on energy conservation techniques.
CO2: To analyze the data for energy monitoring and targeting.
CO3: Discuss the principles of energy management, conservation and auditing in thermal and electrical utilities
CO4: Assess scope of energy conservation in electrical and thermal utilities
CO5: Analysis of economics of energy conservation opportunities in electrical and thermal utilities and reporting of energy audit</td></tr>
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