Semester wise courses for B. Tech. in Agricultural Engineering

Semester – I			
Sl. No.	**Subject**	**Course No.**	**Credit**
1.	Engineering Mathematics - I	MTH 101	3(2+1*)
2.	Engineering Physics	PHY 101	3(2+1)
3.	Engineering Chemistry	CHM 101	3(2+1)
4.	Workshop Practice	ME 101	1(0+1)
5.	Surveying and Leveling	CE 101	3(1+2)
6.	Engineering Drawing	CE 102	2(0+2)
7.	Environmental Science	ES 101	3(3+0)
8.	Electrical Circuits	EE 101	3(2+1)
9.	English and Communication Skills	ENG 101	3(2+1)

Total 24(14+10)

1. Engineering Mathematics-I (MTH 101) 3 (2+1*)

Differential calculus: Taylor's and Maclaurin's expansions; indeterminate form; curvature, asymptotes, tracing of curves, function of two or more independent variables, partial differentiation, homogeneous functions and Euler's theorem, composite functions, total derivatives, derivative of an implicit function, change of variables, Jacobians, error evaluation, maxima and minima. Integral calculus: Reduction formulae; rectification of standard curves, volumes and surfaces of revolution of curves; double and triple integrals, change of order of integration, Gamma and Beta functions, application of double and triple integrals to find area and volume. 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. 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).

2. Engineering Physics (PHY 101) 3 (2+1)

Dia, Para and ferromagnetism-classification. Langevin theory of dia and paramagnetism. Adiabatic demagnetization, Weiss molecular field theory and ferromagnetism. Curie-Weiss law. Wave particle quality, de-Broglie concept, uncertainty principle. Wave function, Time dependent and time independent Schrodinger wave equation, Qualitative explanation of Zeeman effect, Stark effect and Paschan Back effect, Raman spectroscopy. Statement of Bloch's function, Bands in 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 T_c 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 determine 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; Determination of ultrasonic wave velocity in a liquid medium; 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 e.m.f. of a copper-constantan thermocouple with temperature; To find the wave length of light by prism.

3. Engineering Chemistry (CHM 101) 3 (2+1)

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 thermogravimetric, polarographic analysis, nuclear radiation , detectors and analytical applications of radio active 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 preservators, 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 λ_{max} and verification of Beer Lambert Law; Determination of calorific value of fuel; Identification of functional groups (alcohol aldelyde, keline, carbonylic acid and amide) by IR; Chromatographic analysis; Determination of molar refraction of organic compounds.

4. Workshop Practice(ME 101) 1 (0+1)

Practical: Introduction to various carpentry tools, materials, types of wood and their characteristics and Processes OR operations in wood working; Preparation of simple joints: Cross half Lap joint and T-Halving joint; Preparation of Dovetail joint, Mortise and tenor

joint; Introduction to Smithy tools and operations; Jobs on Bending, shaping etc.; Jobs on Drawing, Punching, Rivetting; Introduction to tools and measuring instruments for fitting; Jobs on sawing, filing and right angle fitting of MS Flat; Practical in more complex fitting job; Operations of drilling,, reaming, and threading with tap and dies; Practical test; Introduction to tools and operations in sheet metal work; Making different types of sheet metal joints using G.I. sheets.

5. Surveying and Leveling (CE 101) 3 (1+2)

Surveying: Introduction, classification and basic principles, Linear measurements. Chain surveying. Compass survey. Errors in measurements, their elimination and correction. Plane table surveying. Levelling, Contouring, Computation of area and volume. Theodolite traversing. Introduction to setting of curves.

Practical: Chain survey of an area and preparation of map; Compass survey of an area and plotting of compass survey; Plane table surveying; Leveling. 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.

6. Engineering Drawing (CE 102) 2 (0+2)

Practical: Introduction of drawing scales; 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.

7. Environmental Science (ES 101) 3 (3+0)

Definition, Scope and Importance. Ecosystem: Types, structure and functions : Bio-diversity: value, threats and conservation. Natural Resources: forest, mineral, soil and water –their uses and abuses. Environmental pollution –Causes, effects and control measures of air, water, soil, marine, thermal and noise pollution. Nuclear hazards. Bio-safety and risk assessment. Rural and urban waste management. Global warming. Environmental act and related issues. Human population, health and social welfare.

8. Electrical Circuits (EE 101) 3 (2+1)

Average and effective value of sinusoidal and linear periodic wave forms. Independent and dependent sources, loop current and loop equations (Mesh current method), node voltage and node equations(Nodal voltage method), Network theorems: Thevenin's, Norton's, Superposition, Reciprocity and Maximum power transfer, Star- Delta conversion solution of DC circuit by Network theorems, Sinusoidal steady state response of circuits, Instantaneous and average power, power factor, reactive and apparent power, Concept and analysis of balanced polyphase circuits, Laplace transform method of finding step response of DC circuits, Series and parallel resonance, Classification of filters, constant-k, m-derived, terminating half network and composite filters.

Practical: To familiarize with the components and equipments used in Laboratory; To verify Kirchhoff's current laws; To verify Kirchhoff's voltage laws; To verify Thevenin theorems; To verify Norton's theorems; To verify Superposition theorem; To verify reciprocity theorem; To study the sinusoidal response of RL series circuit; To study the sinusoidal response of RC series circuit; To study the step response of RL series circuit; To study the step response of RC series circuit; To study the response of constant K-filters; To study the response of m-derived filters; To study power consumed in a three-phase circuit.

9. English and Communication Skills (ENG 101) 3(2+1)

Structural and functional grammar: tenses, agreement of verb and subject, punctuation, models, modifiers, conjunction, preposition; Writing: Composition (expository, descriptive argumentative) – developing a thought or an idea within a given word limit introducing theme/idea, formation of paragraphs, conclusion; Report writing, business letters; précis, listing reference material, representation of data by charts, abstracts, graphs and tables, field diary and lab record writing, indexing, footnote and bibliographic procedures; Communication: Introduction to communication, meaning and process of communication, verbal and non-verbal communication, goals of communication, content of communication, ethnography of communication, medium of communication, factors influencing communication, barriers of communication, features of good communication- accuracy, brevity, clarity and appropriateness, listening and note taking, oral presentation skills, reading and comprehension of general and technical articles, individual and group presentations, impromptu presentation, public speaking, group discussion, organizing seminars and conferences.

Practical: Reading Comprehension: Reading at various speeds (slow, fast very fast); reading different kinds of soft texts for different purposes (for example, for relaxation, for information, for discussion at a later stage, etc.); reading between the lines. Speaking: Achieving desired clarity and fluency; manipulating paralinguistic features of speaking (voice quality, pitch, tone, etc.); pausing for effectiveness while speaking; task-oriented, interpersonal, informal and semiformal speaking; oral presentation skills, individual and group presentations. Group Discussion: Use of persuasive strategies including some rhetorical devices (for emphasizing, for instance; being polite and firm; handling questions and taking in criticism of self; turn-taking strategies and effective intervention; use of body language. Listening Comprehension: Telephone conversation, achieving ability to comprehend material delivered at relatively fast speed; comprehending spoken material in Standard Indian English, British English and American English; intelligent listening in situations such as an interview in which one is a candidate. Writing: Listening and note taking, writing skills, field diary and lab record indexing, footnote and bibliographic procedures, précis writing, abstracting.

Semester wise courses for B. Tech. in Agricultural Engineering

Semester – II			
Sl. No.	**Subject**	**Course No.**	**Credit**
1.	Engineering Mathematics – II	MTH 151	3(2+1*)
2.	Computers Programming and Data Structures	CSE 151	3(1+2)
3.	Applied Electronics and Instrumentation	EE 151	3(2+1)
4.	Agriculture for Engineers	AG 151	3(2+1)
5.	Workshop Technology	ME 151	3(1+2)
6.	Thermodynamics & Heat Engines	ME 152	4(3+1)
7.	Field operation and Maintenance of Tractors and Farm Machinery-I	FMP 151	1(0+1)
8.	Engineering Mechanics	CE 151	3(2+1)

Total 23(13+10)

1. Engineering Mathematics-II (MTH 151) 3 (2+1*)

Matrices: Elementary transformations, rank of a matrix, reduction to normal form, Gauss-Jordon method to find inverse of a matrix, consistency and solution of linear equations, Eigen values and Eigen vectors, Cayley-Hamilton theorem, linear transformation, orthogonal transformations, diagonalisation of matrices, Bilinear and quadratic forms. 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).

2. Computer Programming and Data Structures (CSE 151) 3 (1+ 2)

Fundamentals of Computer: History of Computer, Generation of Computer, Classification of Computers Basic Anatomy of Computer System, Primary & Secondary Memory, Processing Unit, Input & Output Data Representation & logic gates Introduction to high level languages, compiler and assembler, interpreter, Primary data types and user defined data types, Variables, typecasting, Operators, Building and evaluating expressions, Standard library functions, Managing input and output, Decision making, Branching, Looping, Arrays, User defined functions, passing arguments and returning values, recursion, scope and visibility of a variable, String functions, Structures and union, Pointers, Stacks, Push/Pop operations, Queues, Insertion and deletion operations, Linked lists, Non-linear Data Structure: Trees - Binary Trees, Traversals, Binary Search Trees, Insertion and Deletion algorithms, Height-balanced trees.

Practical: Familiarizing with Turbo C IDE; Building an executable version of C program; Debugging a C program; Developing and executing simple programs; Creating programs using decision making statements such as if, go to & switch; Developing program using loop

statements while, do & for; Using nested control structures; Familiarizing with one and two dimensional arrays; Using string functions; Developing structures and union; Creating user defined functions; Using local, global & external variables; Using pointers, File Handling.

3. Applied Electronics and Instrumentation (EE 151) 3(2+1)

Semiconductors, p-n junction, V-I characteristics of p-n junction, diode as a circuit element, rectifier, clipper, clamper, 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 K-map), binary ladder D/A converter, successive approximation A/D converter, generalized instrumentation, measurement of displacement, temperature, velocity, force and pressure using potentiometer, resistance thermometer, thermocouples, bourden tube, LVDT, strain gauge and tacho-generator.

Practical: 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 amplifier; 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.

4. Agriculture for Engineers (AG 151) 3 (2+1)

Soils: Nature and origin of soil; soil forming rocks, soil forming processes, important soil physical properties; and their importance; soil particle distribution; soil inorganic colloids – their composition, properties and origin of charge; soil organic matter – its composition and decomposition, effect on soil fertility; essential plants nutrients – their functions and deficiency symptoms in plants; important inorganic fertilizers and their reactions in soils. **Agronomy:** Definition and scope of agronomy. Classification of crops. Principles of tillage, tilth and its characteristics. Soil water plant relationship and water requirement of crops, weeds and their control, crop rotation, cropping systems, Relay cropping and mixed cropping. **Horticulture:** Scope of horticultural crops. Soil and climatic requirements for different horticultural crops, improved varieties, criteria for site selection, layout and planting methods, nursery raising, plant growing structures, pruning and training, fertilizer application, Garden tools, farm implements and structures for horticulture crop management.

Practical: Determination of bulk density; particle density and porosity of soil; Determination of organic carbon of soil; Identification of crops and their varieties seeds and weeds; Different weed control methods; Judging maturity time for harvesting of crop; Study of seed viability and germination test; Identification and description of important horticultural crops;

Study of different garden tools; Preparation of nursery bed; Practices of pruning and training in some important horticultural crops.

5. Workshop Technology (ME 151) 3 (1+2)

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 center lathe, Main accessories and attachments. Main operations and tools used on center 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.

Practical: Introduction to welding equipment, processes tools, their use and precautions; Jobs on ARC welding – Lap joint, butt joint; T-Joint and corner joint in Arc welding; Gas welding Practice – Lab, butt and T-Joints; Introduction to metal casting equipment, tools and their use; Mould making using one-piece pattern and two pieces pattern; Demonstration of mould making using sweep pattern, and match plate patterns; Practical test; Introduction to machine shop machines and tools; Demonstration on Processes in machining and use of measuring instruments; Practical jobs on simple turning, step turning; Practical job on taper turning, drilling and threading; Operations on shaper and planer, changing a round MS rod into square section on a shaper; Demonstration of important operations on a milling machine, making a plot, gear tooth forming and indexing; Any additional job.

6. Thermodynamics and Heat Engines (ME 152) 4 (3+1)

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. Kelvin-Planck and Claussius statements. Reversible processes, Carnot cycle, Carnot theorem. Entropy, physical concept of entropy, change of entropy of gases in thermodynamics processes. Difference between gas and vapour, change of phase during constant pressure process. Generation of steam, triple point and critical point. Internal energy and entropy of steam. Use of steam tables and Mollier chart, heating and expansion of vapour in non-flow processes, measurement of dryness fraction. Classification of steam boilers, Cochran, Lancashire, locomotive and Babcock-Wilcox boilers. Boiler mountings and accessories. Desirable properties of working fluid used for power plants. Rankine cycle. Expansive and non expansive working. Saturation curve and missing quantity, governing. Calculations of cylinder dimensions, Introduction to compound steam engines. Air Standard efficiency, other engine efficiencies and terms. Otto, diesel and dual cycles. Calculation of efficiency, mean effective pressure and their comparison. Measurement of IP, BP and heat balance calculations (not involving combustion). Engine efficiencies and performance.

Practical: Study of boilers; Study of various mountings and accessories of boilers; Study of steam engine; To measure dryness fraction of steam; Performance test of steam engine; Study of I.C. engines; Study of valve timing diagram of 2-stroke engines; Study of valve timing diagram of 4-stroke engines; Performance test on 2- cylinder diesel engines; Performance test

and heat balance test on a four cylinder horizontal diesel engine; Practical test; To conduct Morse test on multi-cylinder petrol engine; Comparison of different temperature measuring methods; To verify inverse square law of radiation; To verify Stefan-Boltzman relationship; To determine the emissivity of a given material.

7. Field Operation & Maintenance of Tractor & Farm Machinery–I (FMP 151) 1(0+1)

Practical: Introduction to various systems of a tractor viz. fuel, lubrication, cooling, electrical, transmission, hydraulic & final drive system. Familiarisation with tractor controls & learning procedure of tractor starting and stopping. Driving in forward and reverse gears. Driving safety rules. Hitching, adjustments, settings and field operation of farm machinery. Familiarisation with different makes & models of 4- wheeled tractors. Starting & stopping practice of the tractor. Familiarisation with instrumentation panel & controls; Road signs, traffic rules, road safety, driving & parking of tractor; Tractor driving practice forward & reverse driving practice; Tractor driving practice with two wheeled tractor trailer forward & reverse; Study and practising the hitching and dehitching of implements; Study operation and field adjustments of m.b. plough & disk plough; Field operation of trailing & mounted disk harrow; Field operation and adjustments of seed drill/planter/sprayer.

8. Engineering Mechanics (CE 151) 3 (2+1)

Basic concepts. 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; a concurrent - coplaner force system, nonconcurrent - coplaner force system, nonconcurrent - noncoplaner force system, parallel - noncoplaner 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 – coplaner and nonconcurrent – coplaner 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.

Semester wise courses for B. Tech. in Agricultural Engineering

Semester – III			
Sl. No.	**Subject**	**Course No.**	**Credit**
1.	Engineering Properties of Biological Materials and Food Quality	PFE 201	3(2+1)
2.	Soil Mechanics	CE 201	3(2+1)
3.	Soil & Water Conservation Engineering	SWC 201	3(2+1)
4.	Farm Machinery and Equipment – I	FMP 201	3(2+1)
5.	Farm Power	FMP 202	3(2+1)
6.	Watershed Hydrology	SWC 202	3(2+1)
7.	Engineering Mathematics - III	MTH 201	3(2+1*)
8.	Agribusiness Management and Trade	ECO 202	3(3+0)

Total 24(17+7)

1. Engineering Properties of Biological Materials & Food Quality (PFE 201) 3 (2+1)

Importance of engineering properties of biological materials, Study of different physical and thermal characteristics of important biological materials like shape, size, volume, density, roundness, sphericity, surface area, specific heat, thermal conductivity, thermal diffusivity, etc. measurement of colour, flavour, consistency, viscosity, texture and their relationship with food quality and composition. Rheological characteristics like stress, strain time effects, rheological models and their equations. Aerodynamic characteristics and frictional properties. Application of engineering properties in handling processing machines and storage structures. Concept, objectives and need of quality, quality control, methods of quality control, sampling; purpose, sampling techniques, requirements and sampling procedures for liquid, powdered and granular materials, sensory quality control, panel selection methods, interpretation of sensory results in statistical quality control, TQM and TQC, consumer preferences and acceptance, Food Laws and Regulations in India. Food grades and standards BIS, AGMARK, PFA, FPO, CAC (Codex Alimantarious Commission), sanitation in food industry , GMP, HACCP (Hazard analysis and critical control point) and ISO 9000 Series.

Practical: To find the shape and size of grains and fruits and vegetables. To determine bulk density and angle of repose of grains. To determine the particle density/true density and porosity of solid grains. To find out the co-efficient of external and internal friction of different crops; To study the separating behaviour of a grain sample in a vertical wind tunner (Aspirator column). To find the thermal conductivity of different grains. To determine specific heat of some food grains. To determine cooking quality of rice. To determine impurities and invisible stress cracks in grains. Preparation of a ready reckoner of change in unit weight of food grains as affected by change in its moisture content (w.b.) (5% - 25%). Milling quality of paddy; Determination of hardness of food material; Detection of adulteration in food products viz. milk, ghee, honey etc.

2. Soil Mechanics (CE 201) 3 (2+1)

Introduction of soil mechanics, field of soil mechanics, phase diagram physical and index properties of soil classification of soils, general classification based on particles size, textural classification and I.S. soil classification system stress condition in soils, effective and neutral stress, elementary concept of Bousinesque and Wester guards analysis, newmark influence chart. 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 perameters by direct shear to be circle, theoretical test. Numerical exercise based on various types of tests. Compaction composition of soils standard and modified protector test, abbot compaction and Jodhpur mini compaction text field compaction method and control. Consolidation of soil: Consolidation of soils, one dimensional consolidation spring analogy, Terzaghi's theory Laboratory consolidation text, calculation of void ratio and coefficient of volume change, Taylor's and Casagrand'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 exercise. Stability of slopes: Introduction to stability analysis of infinite and finite slopes friction circles 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 Triaxial test; Determination of consolidation properties of soils.

3. Soil and Water Conservation Engineering (SWC 201) 3(2+1)

Introduction; soil erosion - causes, types and agents of soil erosion; water erosion - forms of water erosion, mechanics of erosion; gullies and their classification, stages of gully development; soil loss estimation - universal soil loss equation and modified soil loss equation, determination of their various parameters; erosion control measures - agronomical measures - contour cropping, strip cropping, mulching; mechanical measures - terraces - level and graded broad base terraces and their design, bench terraces & their design, layout procedure, terrace planning, bunds - contour bunds, graded bunds and their design; gully and ravine reclamation - principles of gully control - vegetative and temporary structures; wind erosion - factors affecting wind erosion, mechanics of wind erosion, soil loss estimation, wind erosion control measures - vegetative, mechanical measures, wind breaks & shelter belts, sand dunes stabilization; sedimentation - sedimentation in reservoirs and streams, estimation and measurement, sediment delivery ratio, trap efficiency; characteristics of contours and preparation of contour maps; land use capability classification; grassed water ways and their design; introduction to water harvesting techniques; introduction to stream water quality and pollution.

Practical: Study of soil loss measurement techniques; Study of details of Coshocton wheel and multi-slot runoff samplers; Determination of sediment concentration through oven dry

method; Problems on Universal Soil Loss Equation; Preparation of contour map of an area and its analysis; Design of vegetative waterways; Design of contour bunding system; Design of graded bunding system; Design of various types of bench terracing systems; Determination of rate of sedimentation and storage loss in reservoir; Design of Shelter belts and wind breaks.

4. Farm Machinery & Equipment I (FMP 201) 3 (2+1)

Objectives of farm mechanization. Classification of farm machines. Materials of construction & heat treatment. Principles of operation and selection of machines used for production of crops. Field capacities & economics. Tillage; primary and secondary tillage equipment. Forces acting on tillage tools. Hitching systems and controls. Draft measurement of tillage equipment : Earth moving equipment - their construction & working principles viz Bulldozer, Trencher, Elevators etc.; sowing, planting & transplanting equipment - their calibration and adjustments. Fertilizer application equipment. Weed control and Plant protection equipment - sprayers and dusters, their calibration, selection, constructional features of different components and adjustments.

Practical: Introduction to various farm machines, visit to implements shed and research hall; Field capacity and field efficiency measurement for at least two machines/implements; Draft & fuel consumption measurement for different implements under different soil conditions; Construction details, adjustments and working of M.B. plow, disc plow and discharrow and secondary tillage tools; Introduction, construction and working of earth moving equipment; Construction and working of rotavators and other rotary tillers, measurement of speed & working width; Working of seed-cum-fertilizer drills, planters and their calibration in field; Working of transplanters and operation; Weeding equipments and their use; Study of sprayers, dusters, measurement of nozzle discharge, field capacity etc.

5. Farm Power (FMP 202) 3 (2+1)

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. Study of engine components their construction, operating principles and functions. Engine systems : valves & valve mechanism. Fuel & air supply, cooling, lubricating, ignition, starting and electrical systems. Study of constructional details, adjustments & operating principles of these systems. IC engine fuels - their properties & combustion of fuels, gasoline tests and their significance, diesel fuel tests and their significance, detonation and knocking in IC engines, study of properties of coolants, anti freeze and anti-corrosion materials, lubricant types & study of their properties. Engine governing systems.

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

6. Watershed Hydrology (SWC 202) **3 (2+1)**

Introduction; hydrologic cycle; precipitation - forms, rainfall measurement, mass curve, hydrograph, mean rainfall depth, frequency analysis of point rainfall, plotting position, estimation of missing data, test for consistency of rainfall records; interception; infiltration; evaporation; evapo-transpiration - estimation and measurement; geomorphology of watersheds - stream number, stream length, stream area, stream slope and Horton's laws; runoff - factors affecting, measurement; stage and velocity, rating curve, extension of rating curve; estimation of peak runoff rate and volume; rational method, Cook's method, SCS method, Curve number method; hydrograph; components, base flow separation, unit hydrograph theory - unit hydrograph of different durations, dimensionless unit hydrograph, distribution hydrograph, synthetic unit hydrograph, uses and limitations of unit hydrograph; head water flood control - methods, retards and their location; flood routing - graphical methods of reservoir flood routing; hydrology of dry land areas - drought and its classification; introduction to watershed management and planning.

Practical: Visit to meteorological observatory; Study of different types of rain gauges; Exercise on analysis of rainfall data; Double mass curve technique; Determination of average depth of rainfall and frequency analysis; Study of stage recorders and current meters; Exercise on estimation of peak runoff rate and runoff volume; Exercises on hydrograph and unit hydrograph; Exercises on design and location of retards for channel improvement; Exercises on flood routing problems.

7. Engineering Mathematics-III (MTH 201) **3 (2+1*)**

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 t^n, 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.

8. Agribusiness Management and Trade (ECO 202) **3 (3+0)**

Management concepts and principles, process of management, functions of management, concept of agribusiness and application of management principles to agribusiness, production, consumption, and marketing of agricultural products, agricultural processing, meaning and theories of international trade, WTO provisions for trade in agricultural and food commodities, India's contribution to international trade in food and agri - commodities

Semester wise courses for B. Tech. in Agricultural Engineering

Semester – IV			
Sl. No.	**Subject**	**Course No.**	**Credit**
1.	Farm Machinery and Equipment – II	FMP 251	3(2+1)
2.	Irrigation Engineering	SWC 251	4(3+1)
3..	Crop Process Engineering	PFE 251	3(2+1)
4.	Fluid Mechanics	CE 251	3(2+1)
5.	Theory of Machines	ME 251	3(2+1)
6.	Heat and Mass Transfer	ME 252	2(2+0)
7.	Field Operation and Maintenance of Tractors and Farm Machinery – II	FMP 252	2(1+1)
8.	Advance Computer Science & Engineering	CSE 251	2(0+2)
9.	Fundamentals of Probability and Statistics	MTH 251	2(2+0)

Total 23(14+9)

1. Farm Machinery & Equipment-II (FMP 251) 3 (2+1)

Principles & types of cutting mechanisms. Construction & adjustments of shear & impact-type cutting mechanisms. Crop harvesting machinery : mowers, windrowers, reapers, reaper binders and forage harvesters. Forage chopping & handling equipment. Threshing mechanics & various types of threshers. Threshers, straw combines & grain combines, maize harvesting & shelling equipment, Root crop harvesting equipment - potato, groundnut etc., Cotton picking & Sugarcane harvesting equipment. Principles of fruit harvesting tools and machines. Horticultural tools and gadgets. Testing of farm machine. Test codes & procedure. Interpretation of test results. Selection and management of farm machines for optimum performance.

Practical: Familiarization with various Farm machines related to harvesting, threshing, root harvesting, combine etc; Study of various types of mowers, constructional details, materials and working; Study of various types of reaper, constructional details, materials and working & performance; Study of various types of reaper binder, constructional details, materials and working; Study of various types of potato harvesters, constructional details, materials and working; Study of various types of groundnut harvesters, constructional details, materials and working & performance; Study of various types of forage harvester, constructional details, materials and working; Study of various types of sugarcane harvester, constructional details, materials and working; Study of various types of maize sheller, constructional details, materials and working & performance; Study of various types of threshers, constructional details, materials and working & performance; Study of various types of cotton pickers and strippers, constructional details, materials and working; Study of various types of harvester tools, constructional details, materials and working; Study of various types of combine harvester, constructional details, materials and working; Study of various types of straw combines, constructional details, materials and working; Study of various types of fruit harvester equipment, constructional details, materials and working.

2. Irrigation Engineering (SWC 251) 4(3+1)

Irrigation Engineering: Irrigation, impact of irrigation on Human Environment, some major and medium irrigation schemes of India, purpose of irrigation, sources of irrigation water, present status of development and utilization of different water resources of the country; Measurement of irrigation water, weir, notches, flumes and orifices and other methods; water conveyance, design of irrigation field channels, underground pipe conveyance system, irrigation structures, channel lining; land grading, different design methods and estimation of earth work and cost; soil water plant relationship, soil water movement, infiltration, evapo-transpiration, soil moisture constants, depth of irrigation, frequency of irrigation, irrigation efficiencies; surface irrigation methods of water application, border, check basin, furrow and contour irrigation; sprinkler and drip irrigation method, merits, demerits, selection and design; Participatory irrigation management. Economics of water resources utilization.

Practical: Measurement of soil moisture by different soil moisture measuring instruments; measurement of irrigation water; measurement of infiltration rate; computation of evaporation and transpiration; land grading exercises; design of under ground pipe line system; infiltration-advance in border irrigation; measurement of advance and recession in border irrigation and estimation of irrigation efficiency; measurement of advance and recession in furrow irrigation and estimation of irrigation efficiency; measurement of uniformity coefficient of sprinkler irrigation method; measurement of uniformity coefficient of drip irrigation method; field problems and remedial measures for sprinkler and drip irrigation method.

3. Crop Process Engineering (PFE 251) 3 (2+1)

Scope and importance of food processing, principles and methods of food processing. Processing of farm crops; cereals, pulses, oil seeds, fruits and vegetables and their products for food and feed. Processing of animal products, Principal of size reduction, grain shape, size reduction machines; crushers, grinders, cutting machines etc. - operation, efficiency and power requirement – Rittinger's, Kick's and Bond's equation, fineness modulus. Theory of mixing, types of mixtures for dry and paste. materials, rate of mixing and power requirement, mixing index. Theory of separation, size and un sized separation, types of separators, size of screens, sieve analysis, capacity and effectiveness of screens, pneumatic separation. Theory of filtration, study of different types of filters, rate of filtration, pressure drop during filtration. Scope & importance of material handling devices, study of different types of material handling systems; belt, chain and screw conveyor, bucket elevator, pneumatic conveying, gravity conveyor- design consideration, capacity and power requirement.

Practical: Preparation of flow and layout charts of a food processing plant; Determination of fineness modulus and uniformity index; Performance evaluation of hammer mill; Performance evaluation of attrition mill; Study of cleaning equipment; Separation behaviour in pneumatic separation; Study of grading equipment; Evaluation of performance of indented cylinder and screen pre-cleaner; Mixing index and study of mixers; Study of conveying equipments; Performance evaluation of bucket elevator.

4. Fluid Mechanics (CE 251) **3 (2+1)**

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, metacentre and metacentric height, condition of floatation and stability of submerged and floating bodies; Kinematics of fluid flow: Lagrangian and Eulerian description of fluid motion, continuity equation, path lines, streak lines and stream lines, stream function, velocity potential and flow net. Types of fluid flow, translation, rotation, circulation and vorticity, Vortex motion; Dynamics of fluid flow, Bernoulli's theorem, venturimeter, orifice-meter and nozzle, siphon; Laminar flow: Stress-strain relationships, flow between infinite parallel plates - both plates fixed, one plate moving, discharge, average velocity, shear stress and pressure gradient; 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, power transmission through pipe; 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 venturimeter 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 metacentric 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.

5. Theory of Machines (ME 251) **3 (2+1)**

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, co-efficient 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, isochronism, power and effort of a governor. Static and dynamic balancing. Balancing of rotating masses in one and different planes. Partial primary balancing of reciprocating meases.

Practical: Demonstration in mechanisms study using models; Analysis of 4-bar mechanism, slides crank mechanism and their inversions; Complete velocity and acceleration analysis (Graphical or Analytical) of few practical linkage mechanisms; Study of gears and gear trains and motion analysis of some practical complex compound gear train; Motion analysis Epicyclical gear trains using tabular and formula methods; To design a compound gear train and epicyclic gear train for a desired speed ratio; Practical test; To study the flywheel and governor action in laboratory; To graphically synthesize the cam profile for a desired standard follower motion; Study on the cam follower demonstration machine for follower displacement as a function of cam rotation angle and phenomenon of follower jump; Demonstration of static and dynamic balancing in the laboratory. Calculations on balancing a multi rotor unbalanced system by putting masses in two different planers.

6. Heat and Mass Transfer (ME 252) 2 (2+0)

Introductory concepts, 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, critical thickness of insulation. 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 and empirical relationships for free and forced convection. 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-Boltzman 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.

7. Field Operation & Maintenance of Tractors and Farm Machinery-II (FMP 252) 2(1+1)

Introduction to tractor maintenance procedure and trouble shooting. Scheduled maintenance after 10,50,100,250,500 and 1000 hrs. 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 and workshop requirements.

Practical: Familiarisation with tools and equipment used for maintaining & servicing of tractors & farm machines; Doing the 10-hours service jobs & Maintenance after 50- hours of operation; Maintenance after 100 hours of operation; Maintenance after 250 hours of operation; Maintenance after 500 hours and 1000 hours of operation, adjustment of tractor track; Dismantling and assembling of major engine parts; Visit to tractor/ engine repair workshop, injection pump injector repair shop; Doing minor repair of electric, mechanical and hydraulic system; Adjustment and maintenance of primary and secondary tillage equipment viz. m.b. plough, disc-plough and disc harrow etc.; Adjustment and maintenance of seeding & planting and transplanting machines; Adjustment and maintenance of plant

protection equipment; Adjustment and maintenance of reapers & threshers; Adjustment & maintenance of combine harvesters, straw combines, balers etc; Visit to small scale farm machinery manufacturers and their repair shops, seasonal repair of farm machinery.

8. Advance Computer Science & Engineering (CSE 251) 2 (0+2)

C++ - Language - Introduction, Constants, Inputs & Output Operation, Creating programs using decision making statements such as if, go to & switch case, Developing program using loop statements while, do & for, Familiarizing with one and two dimensional arrays, Using string functions, Pointers, File handling, Object Oriented Program.

Java Language - Fundamental of Object Oriented Programme, Java Evaluation, Overview of Java Language, Constants, Variables and Data types, Operators and Expressions, Constructor, Function or Method, Decision Making Statement, Looping, String Functions, Arrays, Encapsulation, Managing Input/Output Files in Java.

9. Fundamentals of Probability and Statistics (MTH 251) 2**(2+0)**

Introduction to statistical data; Measures of central tendency: arithmetic, weighted, geometric, and harmonic means, mode and median for grouped and ungrouped data; Measures of dispersion: range, mean deviation, standard deviation and coefficient of variation; Frequency distribution of grouped and ungrouped data, frequency histogram, binomial, normal, and Poisson distributions; Simple and multiple correlation coefficients; Fitting equation to data, linear regression, curvilinear regression; Tests of significance: 't' test, 'F' test, and chi-square test, confidence levels; Introduction to the theory of probability, definitions of probability, theorem on total and compound probability (for two events only), conditional probability; Random variables: probability mass function and probability density function, mathematical expectation and variance.

Semester wise courses for B. Tech. in Agricultural Engineering

Semester – V			
Sl. No.	**Subject**	**Course No.**	**Credit**
1.	Machine Drawing and Computer Graphics	ME 301	3(2+1)
2.	Machine Design	ME 302	3(2+1)
3.	Dairy & Food Engineering	PFE 301	3(2+1)
4.	Tractor Systems and Controls	FMP 301	3(2+1)
5.	Electrical M/C's and Power Utilization	EE 301	3(2+1)
6.	Database Management and Internet Applications	CSE 301	2(0+2)
7.	Strength of Materials	CE 301	3(2+1)
8.	Ground Water, Wells and Pumps	SWC 301	3(2+1)

Total 23(14+9)

1. Machine Drawing and Computer Graphics (ME 301) 3 (2+1)

First and third angle methods of projection. Preparation of working drawing from models and isometric views. Drawing of missing views. Different methods of dimensioning. Concept of sectioning. Revolved and oblique section. 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 thread. 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. Design process, application of computers for design, definition of CAD, benefits of CAD, CAD system components. Computer hardware for CAD. Display, input and output devices. Graphic primitives, display file, frame buffer, display control, display processors, Line generation, graphics software. Points and lines, Polygons, filling of polygons. Text primitive. Other primitives. Windowing and clipping, view port. Homogeneous coordinates. Transformations. Planar and space curves design. Analytical and synthetic approaches. Parametric and implicit equations. B-spline and Beizer curves. Geometric modeling techniques. Wire frames. Introduction to solid modeling. Introduction to numerical control, basic components of NC system, NC coordinates and motion control systems. Computer numerical control, direct numerical control, combined CNC/DNC. NC machine tools and control units. Tooling for NC machines, part programming, punched tape, tape coding and format, manual and computer assisted part programming.

Practical: Preparation of manual drawings with dimensions from Models and Isometric drawings of objects and machine components; Preparation of sectional drawings of simple machine parts; Drawing of riveted joints and thread fasteners; Demonstration on computer graphics and computer aided drafting use of standard software; Practice in the use of basic and drawing commands on auto cad; Generating simple 2-D drawings with dimensioning using autocad; Practice in the use of modify and rebelling commands; Practice in graphics mathematics, curve fitting and transformations; Demonstration on CNC machine.

2. Machine Design (ME 302) **3 (2+1)**

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 brackets, levers, columns, thin cylindrical and spherical shells. Design of screw motion mechanisms like screw jack, lead screw, etc. Selection of ani-friction bearings. Design of curved beams; Crane hooks, circular rings, etc.

Practical: Problems based on load and stress analysis of machine components; Problems based on practical application of theories of failure and fatigue and determination of factor of safety; Design and drawing of pin connections, Knuckle joint; Design of bolted joints cases of electric loading; Exercises on design of levers rockers arm for diesel engines; Assignment test; Problems on design of shafts, keys and coupling; Problems in selection/ design of belts; Selection of roller bearings use of catalogue; Problems on design of helical and leaf spring; Problems on gear design of spur gears.

3. Dairy and Food Engineering (PFE 301) **3 (2+1)**

Dairy development in India. Engineering, thermal and chemical properties of milk and milk products, unit operation of various dairy and food processing systems, process flow charts for product manufacture, working principles of equipment for receiving, pasteurisation sterilization, homogenisation, filling & packaging, butter manufacture, dairy plant design and layout, composition and proximate analysis of food products. Deterioration in products and their controls. Physical, chemical and biological methods of food preservation, changes undergone by the food components during processing, evaporation, drying, freezing juice extraction, filtration, membrane separation, thermal processing, plant utilities requirement.

Practical: Study of a composite pilot milk processing plant & equipments; Study of pasteurisers; Study of sterilizers; Study of homogenisers; Study of separators; Study of butter churners; Study of evaporators; Study of milk dryers; Study of freezers; Design of food processing plants & preparation of layout; Visit to multiproduct dairy product; Determination of physical properties of food products; Estimation of steam requirements; Estimation of refrigeration requirements in dairy & food plant; Visit to Food industry.

4. Tractor Systems and Controls (FMP 301) **3 (2+1)**

Study of transmission systems, clutch, gear box, differential and final drive mechanism. Familiarization of brake mechanism. Ackerman and hydraulic steering and hydraulic systems. Tractor power outlets: P.T.O., belt pulley, drawbar, etc. Tractor chassis mechanics and design for tractor stability. Ergonomic considerations and operational safety.

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 planetory gears; Study of brake systems and some design problems; Steering geometry and adjustments; Study of hydraulic systems in a tractor, hydraulic trailer and some design problems; Traction performance of a tractor wheel; Finding C.G. of a tractor by weighing technique; Finding CG of a tractor using suspension/balancing techniques; Finding moment of Inertia of a tractor; Appraisal of various controls in different makes tractors in relation to anthropometeric measurements.

5. Electrical Machines and Power Utilization (EE 301) 3 (2+1)

Electro motive force, reluctance, laws of magnetic circuits, determination of ampere-turns for series and parallel magnetic circuits, hysteresis and eddy current losses, Transformer: principle of working, construction of single phase transformer, EMF equation, phasor diagram on load, leakage reactance, transformer on load, equivalent circuit, voltage regulation, power and energy efficiency, open circuit and short circuit tests, 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 motor characteristics, starting of shunt and series motor, starters, speed control methods-field and armature control, polyphase induction motor: construction, operation, equivalent circuit, 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, disadvantage of low power factor and power factor improvement, various methods of single and three phase power measurement.

Practical: To get familiar with AC, DC machines and measuring instruments; To perform open circuit and short circuit tests on a single phase transformer and hence find equivalent circuit, voltage regulation and efficiency; To study the constructional details of D.C. machine and to draw sketches of different components; 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.

6. Database Management and Internet Applications (CSE 301) 2 (0+2)

Practical: Basic database concepts, introduction to RDBMS, SQL Commands DDL, DML, Data constraints; Creating a Table, Specifying Relational Data Types, **Table and Record Handling (**INSERT statement, DELETE, UPDATE, TRUNCATE statements, DROP, ALTER statements),Select command, Joins and functions; Group functions, Set functions, Joins, set operations, Sub-queries, working with forms, Basics of HTML, developing web pages using meta tags, dynamic pages using Java scripts, connectivity with RDBMS, Project.

7. Strength of Materials (CE 301) 3 (2+1)

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 behaviour 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

8. Groundwater, Wells and Pumps (SWC 301) 3 (2+1)

Occurrence and movement of ground water, aquifer and its types, classification of wells, steady and transient flow into partially, fully and non-penetrating and open wells, familiarization of various types of bore wells common in the state, design of open well, groundwater exploration techniques, methods of drilling of wells, percussion, rotary, reverse rotary, design of assembly 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 etc. Theis recovery method, well interference, multiple well systems, surface and subsurface exploitation and estimation of

ground water potential, quality of ground water, artificial groundwater recharge planning, modelling, ground water project formulation. Pumping Systems: Water lifting devices; different types of pumping machinery, classification of pumps, component parts of centrifugal pumps; pump selection, installation and trouble shooting; design of centrifugal pumps, performance curves, effect of speed on head capacity, power capacity and efficiency curves, effect of change of impeller dimensions on performance characteristics; hydraulic ram, propeller pumps, mixed flow pumps and their performance characteristics; priming, self priming devices, rotodynamic pumps for special purposes such as 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; Drilling of a tubewell; Measurement of water level and drawdown in pumped wells; Estimation of aquifer parameters by Thies 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 performance characteristics of hydraulic ram; Study and testing of submersible pump.

Semester wise courses for B. Tech. in Agricultural Engineering

Semester – VI			
Sl. No.	**Subject**	**Course No.**	**Credit**
1.	Agricultural Structures and Environmental Control	CE 351	3(2+1)
2.	Drying and Storage Engineering	PFE 352	4(3+1)
3.	Design of Structures	CE 351	3(2+1)
4.	Drainage Engineering	SWC 351	2(1+1)
5.	Soil & Water Conservation Structures	SWC 352	3(2+1)
6.	Refrigeration and Air conditioning	PFE 353	3(2+1)
7.	Entrepreneurship Development	EXT 351	1(1+0)
8.	Renewable Energy Sources	FMP 351	3(2+1)

Total 22(15+7)

1. Agricultural Structures and Environmental Control (CE 351) Credit: 3(2+1)

Theory:- Planning and layout of farm shed. Design, construction and cost estimation of farm structures, animal shelters, compost pit, fodder silo, fencing and implement sheds, planning and designing dairy barns, stall barns and loose houses, milking parlor, labour efficiency and waster management. Poultry housing requirements, common types of poultry houses and their planning. Design and construction of rural grain storage system Engineering for 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-its design, cost and maintenance, design of septic tank for small family. Environmental pollution and their control, solid waste management system, BOD and COD of food plant waste, primary and secondary treatment of food plant waste.

Practical: Cooling load of farm building e.g. poultry house. Moisture condensation in agricultural buildings. Design of layout of dairy farm. Design and layout of poultry house. Design and layout sheep/goat house. Design of biogas plant. Design of a farm fencing system. Design of ventilation system for dairy and poultry house. Design of feed/fodder storage structures. Familiarization with local grain storage structures. Design of grain storage structures. Cost estimation of a farm buildings. Design of rural/farm roads and culverts.

2. Drying and Storage Engineering (PFE 351) 4(3+1)

Moisture content and methods for determination, importance of EMC and methods of its determination, EMC curve and EMC model, principle of drying, theory of diffusion, mechanism of drying- falling rate, constant rate, thin layer, deep bed and their analysis, critical moisture content, drying models, calculation of drying air temperature and air flow rate, air pressure within the grain bed, Shred's and Hukill's curve, different methods of drying including puff drying, foam mat drying, freeze drying, etc. Study of different types of dryers- performance, energy utilization pattern and efficiency, study of drying and dehydration of agricultural products. Types and causes of spoilage in storage, conditions for storage of perishable products, functional requirements of storage, control of temperature and relative humidities inside storage, calculation of refrigeration load; modified atmospheric storage and control of its environment, air movement inside the storage, storage of grains:

destructive agents, respiration of grains, moisture and temperature changes in stored grains; conditioning of environment inside storage through natural ventilation, mechanical ventilation, artificial drying, grain storage structures such as Bukhari, Morai, Kothar, silo, CAP, warehouse - design and control of environment. Storage of cereal grains and their products, storage of seeds, hermetically sealed and air-cooled storages-refrigerated, controlled atmosphere, modified atmospheric and frozen storages. Storage condition for various fruits and vegetables under cold and CA storage system. Economic, aspects of storage.

Practical: Study of mechanics of bulk solids affecting cleaning, drying and storage of grains; Measurement of moisture content during drying and aeration; Measurement of relative humidity during drying and aeration using different techniques; Measurement of air velocity during drying and aeration; Drying characteristic and determination of drying constant; Determination of EMC and ERH; Study of various types of dryers; To study the effect of relative humidity and temperature on grains stored in gunny bags; Design and layout of commercial bag storage facilities; Design and layout of commercial bulk storage facilities; Study of different domestic storage structures; Visits to commercial handling and storage facilities for grains.

3. Design of Structures (CE 352) 3 (2+1)

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.

Practical: Design and drawing of steel roof truss; Design and drawing of RCC building; Design and drawing of Retaining wall.

4. Drainage Engineering (SWC 351) 2 (1+1)

Drainage, objectives of drainage, familiarization with the drainage problems of the state, Surface drainage, drainage coefficient, types of surface drainage, design of open channel, sub-surface drainage purpose and benefits, investigations of design parameters, hydraulic conductivity, drainable porosity, water table etc., types and use of subsurface drainage system, Design of surface drains, interceptor and relief drains. Derivation of ellipse (Hooghoudt's) and Ernst's drain spacing equations. Design of subsurface drainage system. Drainage materials, drainage pipes, drain envelope. Layout, construction and installation of drains. Drainage structures. Vertical drainage. Bio-drainage. Tile Drains. Drainage of irrigated and humid areas. Salt balance, reclamation of saline and alkaline soils. Leaching requirements, conjunctive use of fresh and saline waters. Economic aspects of drainage.

Practical: In-situ measurement of hydraulic conductivity; determination of drainage coefficients; installation of piezometer and observation well; preparation of iso-bath and iso-bar maps; measurement of hydraulic conductivity and drainable porosity; design of surface drainage systems; design of subsurface drainage systems; determination of chemical properties of soil and water; fabrication of drainage tiles; testing of drainage tiles; determination of gypsum requirement for land reclamation; installation of sub-surface drainage system; cost analysis of surface and sub-surface drainage system.

5. Soil and Water Conservation Structures (SWC 352) 3 (2+1)

Introduction; classification of structures, functional requirements of soil erosion control structures; flow in open channels-types of flow, state of flow, regimes of flow, energy and momentum principles, specific energy and specific force; hydraulic jump and its application, type of hydraulic jump, energy dissipation due to jump, jump efficiency, relative loss of energy; runoff measuring structures-parshall flume, H - flume and weirs; straight drop spillway - general description, functional use, advantages and disadvantages, structural parts and functions; components of spillway, hydrologic and hydraulic design, free board and wave free board, aeration of weirs, concept of free and submerged flow, structural design of a drop spillway-loads on headwall, variables affecting equivalent fluid pressure, determination of saturation line for different flow conditions, seepage under the structure, equivalent fluid pressure of triangular load diagram for various flow conditions, creep line theory, uplift pressure estimation, safety against sliding, over turning, crushing and tension; chute spillway-general description and its components, hydraulic design, energy dissipaters, design criteria of a SAF stilling basin and its limitations, drop inlet spillway- general description, functional use, design criteria; design of diversions; small earth embankments-their types and design principles, farm ponds and reservoirs, cost estimation of structures.

Practical: Design of H-flume; Design of Parshall flume; Construction of specific energy and specific force diagram; Measurement of hydraulic jump parameters and amount of energy dissipation; Hydraulic design of a straight drop spillway; Determination of uplift force and construction of uplift pressure diagram; Determination of loads on headwall and construction of triangular load diagram; Stability analysis of a straight drop spillway; Hydraulic design of a chute spillway; Design of a SAF energy dissipater; Design of small earth embankments and water harvesting structures; Cost estimation of structures.

6. Refrigeration and Air Conditioning (PFE 352) 3(2+1)

Principles of refrigeration, second law of thermodynamics applied to refrigeration, carnot cycle, reversed carnot cycle, coefficient of performance, unit of refrigeration. Refrigeration in food industry, types of refrigeration system, mechanical vapour compression, vapour absorption system, components of mechanical refrigeration, refrigerant, desirable properties of ideal refrigerant, Centrifugal and steam jet refrigeration systems, thermoelectric refrigeration systems, vortex tube and other refrigeration systems, ultra low temperature refrigeration, cold storages, insulation material, design of cold storages, defrosting. 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 and calculations, types of air conditioners – applications.

Practical: Study of vapour compression and vapour absorption systems; Study of eletrolux refrigerator; Solving problems on refrigeration on vapour absorption system; Experiments with the refrigeration tutor to study various components of refrigeration; Determination of the coefficient of performance of the refrigeration tutor; Experiment on humidifier for the

determination of humidifying efficiency; Experiment on dehumidifier for the determination of dehumidifying efficiency; Experiment on the cooling efficiency of a domestic refrigerator; Experiments on working details of a cold storage plant and air conditioning unit; Experiments with air conditioning tutor to study various components; Determination of the coefficient of performance of air condititiong tutor; Estimation of refrigeration load; Estimation of cooling load for air conditioner; Estimation of humidification and dehumidification load; Design of complete cold storage system.

7. Entrepreneurship Development (EXT 351) 1(1+0)

Theory:
Entrepreneurship behaviour, Entrepreneurship development, Entrepreneurship management – Meaning, Concepts, Need for enterprise emergence and characteristics of an Entrepreneur; Factors affecting Entrepreneurial growth-Economic, Social, Cultural, Technological, Situational and Legal requirements for establishment of a new unit; Entrepreneurial motivation and competencies; Establishment of a small business – Identification, selection, formulation and appraisal of a sound enterprise, Infrastructure and Policy support for Entrepreneurship development; Management in small enterprise-basic concepts of capital management, inventory management, production and operation management, marketing and human resource management, production and orientation management. Technical Appraisal – Factors to be considered for personnel training; SWOT analysis, Network Analysis, Critical Path Method (CPM), PERT. Causes, consequences and corrective measures for industrial sickness.

8. Renewable Energy Sources (FMP 351) 3(2+1)

Classification of energy sources; Introduction to renewable energy sources; characterization of biomass; types, construction, working principle, uses and safety/environmental aspects of different renewable energy devices like gasifiers, biogas plants, solar passive heating devices, photovoltaic cells and arrays; Brief introduction to wind energy, hydroelectric energy, ocean energy, briquetting and baling of biomass, biomass combustion, biodiesel preparation and energy conservation in agriculture.

Practical: Preparation of biomass sample; Determination of calorific value; Estimation of ash content of biomass; Estimation of moisture content of biomass; Estimation of fixed carbon and volatile matter of biomass; Demonstration of down draft throatless rice husk gasifier; Demonstration of down draft gasifier with throat; Demonstration of rice husk gasifier for thermal use; Demonstration of working of a fixed dome type biogas plants; Demonstration of working of a floating drum type biogas plants; Demonstration of biodiesel preparation; Measurement of basic solar parameters; Demonstration of solar water heater; Demonstration of PVC; Demonstration of solar cooker; Determination of fuel properties.

Semester wise courses for B. Tech. in Agricultural Engineering

Semester – VII

Sl. No.	Subject	Course No.	Credit
1.	PROJECT - I	PRJ 401	3(0+3)
2.	SEMINER	SEM 401	1(0+1)
3.	In Plant/Industrial Training-I	TRN 401	4 (0+4)

Student will have to take minimum of **15 credits** courses from the following cafeteria courses

Sl. No.	Subject	Course No.	Credit
1.	Food Packaging Technology	PFE 401	3(2+1)
2.	Design & Maintenance of Green House	PFE 402	3(2+1)
3.	Waste and By-Product Utilization	PFE 403	3(2+1)
4.	Development of Processed Products & Equipments	PFE 404	3(2+1)
5.	Food Processing Plant Design and Layout	PFE 405	3(2+1)
6.	Micro Irrigation Systems Design	SWC 401	3(2+1)
7.	Watershed Planning and Management	SWC 402	3(2+1)
8.	Minor Irrigation & Command Area Development	SWC 403	3(2+1)
9.	Environmental Engineering	CE 401	3(2+1)
10.	Gulley & Ravine Control Structures	SWC 404	3(2+1)
11.	Remote Sensing & GIS Applications	SWC 405	3(2+1)
12.	Reservoir & Farm Pond Design	SWC 406	3(2+1)
13.	Tractor Design & Testing	FMP 401	3(2+1)
14.	Hydraulic Drive & Controls	FMP 402	3(2+1)
15.	Farm Power & Machinery Management	FMP 403	3(2+1)
16.	Renewable Energy Technology	FMP 404	3(2+1)
17.	Human Engineering & Safety	FMP 405	3(2+1)
18.	Biomass Management for fodder & Energy	FMP 406	3(2+1)
19.	Production Technology of Agricultural Machinery	FMP 407	3(2+1)
20.	Mechanics of Tillage and Traction	FMP 408	3(2+1)
21.	System Engineering	MTH 401	3(3+0)

Total 23

1. PROJECT-I (PRJ 401) **3(0+3)**

Finalization of project topic, survey of relevant literature, definition of objectives, proposed methodology, presentation on the previous topics and progress of work.

2. SEMINER (SEM 401) **1(0+1)**

Introduction to audio-visual tools for the presentation of scientific work to the audience. Development of skills to prepare a good presentation material. To learn the art of delivering oral presentation on contemporary research work. The final evaluation will be made based on scientific paper presentation by the students in relevant subjects of Agricultural Engineering.

3. In Plant/Industrial Training-I (TRN 401) **4(0+4)**

The student will undergo Practical Training of one (01) month duration at suitable training institutes/organizations/industries in 4th semester of the degree programme. The students will be evaluated in this course based on training report submission, presentation and viva-voce.

4. CAFETERIA COURSES

1. Food Packaging Technology (PFE 401) **3(2+1)**

Factors affecting shelf life of food material during storage; spoilage mechanism during storage; definition, requirement, importance and scope of packaging of foods; types and classification of packaging system; advantage of modern packaging system. Different types of packaging materials used. Different forms of packaging, metal container, glass container, plastic container, flexible films, shrink packaging, vacuum & gas packaging. Packaging requirement & their selection for the raw & processed foods. Advantages & disadvantages of these packaging materials; effect of these materials on packed commodities, Package testing, Printing, labeling and lamination. Economics of packaging; performance evaluation of different methods of packaging food products; their merits and demerits; scope for improvements; disposal and recycle of packaging waste.

Practical: Identification of different types of packaging materials; determination of tensile strength of given material; Determination of compressive strength of given package; To perform different destructive tests for glass containers; To perform non-destructive tests for glass containers; Vacuum packaging of agricultural produces; Determination of tearing strength of paper board; measurement of thickness of packaging materials; To perform grease-resistance test in plastic pouches; Determination of bursting strength of packaging material; Determination of water-vapour transmission rate; Shrink wrapping of various horticultural produce; Testing of chemical resistance of packaging materials; Determination of drop test of food package; Visit to relevant industries.

2. Design and Maintenance of Greenhouse (PFE 402) **3(2+1)**

History and types of greenhouse; importance, function and features of green house; scope and development of green house technology. Location, Planning and various component of greenhouse; design criteria and calculation; constructional material and methods of construction; covering materials and its characteristics, solar heat transfer, solar fraction for green house, steady state analysis of green house, Greenhouse heating, cooling, shedding and ventilation systems; Carbon Dioxide generation and monitoring and lighting systems, instrumentation & computerized environmental Control Systems. Watering, fertilization, root substrate and its pasteurization, containers and benches, plant nutrition. Alternative cropping systems; plant tissue culture, chemical growth regulation; disease control; integrated pest management; postproduction quality and handling Cost analysis of greenhouse production; Applications of green house & its repair & maintenance.

Practical: Study/visit to a functional green house; planning and layout of green house & associated utilities; Material selection for the construction of green house; Measurement of temp. using thermomseter, thermistor & thermocouples inside the green house; Measurement of humidity & air velocity using various methods; Measurement of solar radiations inside the

green house; Application of psychometric charts; estimation of cooling requirements in a green house; estimation of ventilation requirements; Thermal performance of green house; Application of data loggers for simultaneous estimation & control of different parameters like temp., RH, solar radiations etc.; Calculations of environment indices inside a green house; Structural analysis of green house; Economic analysis of green house; Visit to a commercial green house.

3. Waste and By-Product Utilization (PFE 403) 3(2+1)

Types and formation of byproducts and waste; magnitude of waste generation in different food processing industries; 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 vermi-composting, Pre-treatment of waste: sedimentation, coagulation, flocculation and floatation, Secondary treatments: Biological and chemical oxygen demand for different food plant waste– trickling filters, oxidation ditches, activated sludge process, rotating biological contractors, lagoons, Tertiary treatments: Advanced waste water treatment process-sand, coal and activated carbon filters, phosphorous, sulphur, nitrogen and heavy metals removal, Assessment, treatment and disposal of solid waste; and biogas generation.

Practical: Waste characterization: (a) temperature (b) pH (c) solids content (d) turbidity (e) BOD (f) COD; **D**etermination of ash content of agril. wastes; **D**etermination of unburnt carbon in ash of paddy straw; To study about briquetting of agricultural residues; Estimation of excess air for better combustion of briquettes; To study about extraction of oil from rice bran; To study about waste treatment plant in food industry; To study about utilization of whey; To study about recovery of peel oil; To study about recovery of germ and germ oil from by-product of cereals; Practical on bioconversion of agro-wastes; Practical on recycling of agro-wastes and by-products; Visits to various industries using waste and food by-products.

4. Development of Processed Products & Equipments (PFE 404) 3(2+1)

Applications of unit operations to the food industry, analytical processing concepts with regards to mass and energy balances, equipment involved in the commercially important food processing methods and unit operations; value addition to cereals like rice, wheat etc. Parboiling of rice, quality of processed products of rice & wheat. Processing of pulses, spices and condiments; extruded food product, fermented food product, frozen and dried product, technology of meat, fish and poultry products, technology of milk and milk products. Technology of oilseeds and fat products, snack foods, Fruits and vegetables product: candy, nutraceuticals, food product development trends, food additives and labeling. Process equipment for thermal processing-evaporation, dehydration, drying, blenching, pasteurization, distillation; mechanical separation-filtration, sieving, centrifugation,

sedimentation; mechanical handling-conveying and elevation; size reduction and classification-mixing; kneading, blending.

Practical: Working principle and operation of Engleberg huller; study of different cleaners and graders used in agro processing industries; working principle, operation and maintenance of paddy destoner-cum-cleaner, rubber roll sheller, paddy separator and vertical cone whitener; familiaraization with operation and performance of machinery and equipments of Satake rice milling unit of 500 kg/hr; planning and layout of roller wheat flour milling & rice milling; visit to milk plant; visit to roller flour mill; visit to markfed canneries; visit to fruit/vegetable processing plants; flow process diagram and study of various models of the machines used in a sugar mill.

5. Food Processing Plant Design & Layout (PFE 405) 3(2+1)

Meaning and definition of plant layout. Objectives and principles of layout. Types of layout. Salient features of processing plants for cereals, pulses oilseeds, horticultural and vegetable crops, poultry, fish and meat products, milk and milk products. Location selection criteria, selection of processes, plant capacity, project design, flow diagrams, selection of equipments, process and controls, handling equipments, plant layout, Plant elevation, requirement of plant building and its components, labour requirement, plant installation, power and power transmission, sanitation. Cost analysis, preparation of feasibility report.

Practical: Planning, visit and layout of flour milling plant; Planning, visit and layout of rice milling plant; Planning, visit and layout of milk plant; Planning, visit and layout of bakery plant; Planning, visit and layout of fruits and vegetable dehydration plant; Planning, visit and layout of beverages industry; Planning, visit and layout of edible of extraction plant; Planning, visit and layout of ice-cream plant; Planning, visit and layout of sugar mill plant; Planning, visit and layout of honey/turmeric/chillies processing plant.

6. Micro Irrigation Systems Design (SWC 401) 3(2+1)

Past, present and future need of micro-irrigation systems, Role of Govt. for the promotion of micro-irrigation in India, Merits and demerits of micro-irrigation system, Types and components of micro-irrigation system, Micro-irrigation system- design, design synthesis, installation, and maintenance. Sprinkler irrigation - types, planning factors, uniformity and efficiency, laying pipeline, hydraulic lateral, sub-mains and main line design, pump and power unit selection. Drip irrigation – potential, automation, crops suitability. Fertigation – Fertilizer application criteria, suitability of fertilizer compounds, fertilizer mixing, injection duration, rate and frequency, capacity of fertilizer tank. Quality control in micro-irrigation components, design and maintenance of polyhouse; prospects, waste land development – hills, semi-arid, coastal areas, water scarce areas, Benefit and Cost analysis.

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

climate inside a Polyhouse; Study of maintenance and cleaning of different components of various systems; Design of sprinkler irrigation system; Design of landscape irrigation system

7. Watershed Planning and Management (SWC 402) 3(2+1)

Watershed management - problems and prospects; watershed based land use planning, watershed characteristics – physical and geomorphologic, factors affecting watershed management, hydrologic data for watershed planning, watershed delineation, delineation of priority watershed, water yield assessment and measurement from a watershed; hydrologic and hydraulic design of earthen embankments and diversion structures; sediment yield estimation and measurement from a watershed and sediment yield models; rainwater conservation technologies - in-situ and storage, design of water harvesting tanks and ponds; water budgeting in a watershed; effect of cropping system, land management and cultural practices on watershed hydrology; evaluation and monitoring of watershed programmes; people's participation in watershed management programmes; planning and formulation of project proposal; cost benefits analysis of watershed programmes; optimal land use models; case studies.

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

8. Minor Irrigation and Command Area Development (SWC 403) 3(2+1)

Major, medium and minor irrigation projects – their comparative performance; development and utilization of water resources through different minor irrigation schemes. Basic concepts of command area – definition, need, scope, and development approaches: historical perspective, command area development authorities; Interaction/collaboration of irrigation water use efficiency and agricultural production. Planning and execution of on farm development activities with in the scope of command area development; Use of remote sensing techniques for command area development; case studies of some selected commands; Farmers participation in command area development.

Practical: Topographic survey and preparation of contour map; preparation of command area development layout plan; land leveling design for a field; earthwork and cost estimation; irrigation water requirement of crops; preparation of irrigation schedules; planning and layout of water conveyance system; design of Irrigation systems; conjunctive water use planning; application of remote sensing for command area development; technical Feasibility and economic viability of a command area project. Study tour to minor irrigation and command area development projects.

9. Environmental Engineering (CE 401) 3(2+1)

Importance of safe water supply system. Domestic water requirements for urban and rural areas. Sources of Water supply. Intakes and transportation of water. Drinking water quality. Indian Standards of drinking water. Introduction to water treatment. Importance of sanitation. Domestic waste water: quantity, characteristics, disposal in urban and rural areas. Sewer:

types, design discharge and hydraulic design. Introduction to domestic wastewater treatment. Design of septic tank. Solid waste: quantity, characteristics and disposal for urban and rural areas. Introduction to air pollution. Types of pollutants properties and their effects on living beings. ISI standards for pollutants in air and their abetments.

Practical: Determination of turbidity; pH of solution; Suspended solids; Dissolved solids; Total solids; Temporary hardness; Permanent hardness; Fluorides; Chlorides, dissolved oxygen; BOD; Collection of air samples and their analysis; Numerical problems related to theory; Visit to treatment plant.

10. Gulley and Ravine Control Structures (SWC 404) 3(2+1)

Introduction; 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 methods of flood control measures, storage and detention reservoirs, levees, channel improvement; Gulley erosion and its control; soil erosion and sediment control measures; river training works, planning of flood control projects and their economics.

Practical: Determination of flood stage-discharge relationship in a watershed; determination of flood peak-area relationships. Determination of frequency distribution functions for extreme flood values using Gumbel's method; Determination of frequency distribution functions for extreme flood values using log-Pearson Type-III distribution; Determination of confidence limits of the flood peak estimates for Gumbel's extreme value 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 Gulley stabilization; Designing and planning of a flood control project; Cost and benefit analysis of a flood control project.

11. Remote Sensing and GIS Application (SWC 405) 3(2+1)

Remote Sensing: Definition and principles of remote sensing; Energy sources and radiation principles; Nature of electromagnetic and thermal radiations; Propagation of radiations through the atmosphere; Atmospheric window; Active and passive remote sensing systems; Types of remote sensors and scanners; Satellite data products; Spatial temporal, spectral, and radiometric resolutions; Spectral signatures of different earth features (vegetation, soil, and water); Vegetation indices; Background and history of Indian Space Programme; Image interpretation: True color, Pseudo color and False Color Compositions; Visual image interpretation: elements of image interpretation, techniques of image interpretation; Digital image processing: image pre-processing, image processing, image transformation; Image classification: supervised and unsupervised classifications; Introduction to microwave radiometry.

Global Positioning System (GPS): Introduction to GPS navigation techniques; GPS satellites; Segments of GPS systems; Principles of GPS navigation; GPS broadcast signals; Accuracy of

GPS systems; Sources of error in GPS; Error corrections; Principles of Pseudo range and differential GPS systems.

Geographic Information System (GIS): Definition and objectives of GIS; Basic components of GIS and standard GIS packages; Types of data: spatial and attribute data, data-entry, storage and maintenance, query operations; data structure; Data format: raster and vector data models in GIS; Basic analysis tools in GIS: buffer analysis and overlay analysis.

Practical: Familiarization with remote sensing and GIS hardware and softwares; interpretation of satellite imagery; introduction to topographic sheets; on-screen digitization of maps; Digital image processing; Image enhancement techniques; Image classification: supervised and unsupervised classifications; Creation of simple GIS database and data base query; GIS supported case studies in water resources management.

12. Reservoir and Farm Pond Design (SWC 406) 3(2+1)

Earthen embankments - functions, advantages and disadvantages, classification - hydraulic fill and rolled fill dams - homogeneous, zoned and diaphragm type; foundation requirements, grouting, seepage through dams - estimation of seepage discharge, location of seepage/phreatic line by graphical and analytical methods, 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 slice method; types of reservoirs and farm ponds, design and estimation of earth work; cost analysis.

Practical: Study of different types and materials 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; Stability analysis of earthen dams against foundation shear; Stability analysis of earth dams against sudden draw down condition; Stability of slopes of earth dams by friction circle method / different methods; construction of flow net for isotropic and anisotropic medium; Computation of seepage by different methods; determination of settlement of earth dam; Input-output-storage relationships by reservoir routing; design of farm ponds; cost estimation of farm ponds and other structures.

13. Tractor Design and Testing (FMP 401) 3(2+1)

Procedure for design and development of agricultural tractor, Study of parameters for balanced design of tractor for stability & weight distribution, hydraulic lift and hitch system design. Design of mechanical power transmission in agricultural tractors. Design of Ackerman Steering and tractor hydraulic systems. Study of special design features of tractor engines and their selection. Design of seat and controls of an agricultural tractor. Tractor Testing.

Practical: Design problem of tractor clutch – (Single/ Multiple disc clutch); Design problem on spur gears; Design problem of bevel gears; Design problem of helical gears; Design of gear box(synchromesh/constant mesh); Design of variable speed constant mesh drive; Selection of tractor tires – Problem solving; Problem on design of governer; Problem related to selection of hydraulic pump; Engine testing as per BIS code – various test; 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.

14. Hydraulic Drives and Controls (FMP 402) 3(2+1)

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, Performance, Displacement, Designs, Gear Pumps, Vane Pumps, Piston Pumps, Pump Operation. 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 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: Use of Hydraulics and Pneumatics drives in agricultural systems, PLCs (Programmable Logic Controls).

Practical: Introduction to Hydraulic Systems; Study of Hydraulic Pumps; Study of Hydraulic Actuators; Study of Hydraulic Motors; Study of Hydraulic Valves; Hydraulic 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.

15. Farm Power & Machinery Management (FMP 403) 3(2+1)

The role of mechanization and its relationship to productivity, employment, social and technological change; performance and power analysis; cost analysis of machinery: fixed cost and variable costs, effect of inflation on cost; selection of optimum machinery and replacement criteria; Break-even analysis, reliability and cash flow problems; mechanization planning; case studies of agricultural mechanization in India.

Practical: Solving problems related to Various capacities, pattern efficiency, system limitation, power requirement and other operational parameters; Solving of Problems related to cost analysis and inflation; Solving problem related to selection of equipment, replacement, break-even analysis, time value of money etc.; Presentation of seminar on topic assigned related to farm machinery management; Design of farm mechanization plan for different farm size and cropping pattern.

16. Renewable Energy Technologies (FMP 404) 3(2+1)

Design and operational parameters, performance evaluation and maintenance aspects of different renewable technologies like gasifiers, biogas plants, solar passive heating devices, photovoltaic cells and arrays, briquetting machines and balers; bio-diesel utilization in CI engines.

Practical: Performance evaluation of solar water heater; performance evaluation of solar cooker; Characteristics of solar photovoltaic panel; evaluation of solar air heater/dryer;

Performance evaluation of a rice husk throatless gasifier engine system; Performance evaluation of down draft gasifier with throat for thermal application; Performance evaluation of a fixed dome type biogas plant; Performance evaluation of floating drum type biogas plant; Estimation of calorific value of producer gas; Testing of diesel engine operation using biodiesel; Evaluation of briquetting machine using biomass material; evaluation of rice straw briquette.

17. Human Engineering and Safety (FMP 405) 3(2+1)

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 Ergometer as loading device, versus different physiological parameters; Calibration of the subject in the laboratory using mechanical treadmill as loading device versus different physiological parameters; Study of Respiration gas meter and its use in selected farm operation and their comparison from energy point of view; Calibration of the subject using Heart Rate Monitor and farm operation as a loading device; Study of general fatigue of the subject using Blink ratio method; Study on the use of electromyograph equipment; Anthropometric measurements of a selected group of farm workers and its statistical analysis; Study of optimum work space layout and locations of controls of different factors; Familiarization of the noise and vibration equipment.

18. Biomass Management for Fodder and Energy (FMP 406) 3(2+1)

Introduction to biomass management, biomass resource assessment management techniques/supply chains, Processing of paddy straw, densification- Extrusion process, pellets, mills and cubers, Bailing-classification, uses; residue management for surface mulch and soil incorporation, Paddy Straw choppers and spreaders as an attachment to combine Harvester, Mulch seeder, Paddy Straw Chopper-cum-Loader, Balar for collection of straw; Processing of straw/ fodder for animal use; Agricultural and horticultural use, Cushioning material for fruits and vegetables, Mulching and Composting, Paper and cardboard manufacturing, Straw as a fuel.

Practical: Familiarization with different straw management techniques; on-farm and off-farm uses of straw; collection, loading and transport equipments for unbruised loose straw; briquetting machine and preparation of briquettes; straw baler and making of bales in the field; straw/ fodder chopping machines; straw/ mulching & incorporating machinery; machinery requirement for baling forage crops for silage**.**

19. Production Technology of Agricultural Machinery (FMP 407) 3(2+1)

Critical appraisal in production of Agricultural Machinery; Modelling and stress analysis of Machinery parts by using standard software; Advances in material used for tractor & Agril.

Machinery. Cutting tools including CNC tools and finishing tools. Advanced manufacturing techniques like powder metallurgy, EDM (Electro-Discharge Machining), Heat Treatment of steels including pack carburizing, shot pining process, chemical vapor deposition (CVD) etc. Limits, Fits & Tolerances, Jigs & Fixtures, Microstructure Analysis. Industrial lay-out planning, Quality management,. Economics of process selection. Techno-economic feasibility of Project Report. Selection of Standard/ critical components. Case studies of manufacturing of agril. machinery. Servo motors, drives & controllers, CNC controllers for machine tools. CNC programming. Assembly and plant automation. Storage and transportation.

Practical: To draw an exhaustive design plan for a machine & describe its kinematics; Part modelling of agril. machinery by using standard software; Problem on design of cultivator and drill parts; Problem on design of sprayer parts and fluid flow; Problem on design of harvesting and threshing machinery parts; Visit to Central Tool Room/ Industry with Advanced manufacturing techniques; Jigs and Fixtures – study in relation to Agril Machinery; Design problems on fits, tolerances and limits; Layout planning of a small scale industry; Problem on Economics of process selection; Preparation of a project report; Case study for manufacturing of weeder/ thresher through industry visit; Study of different CNC controllers/ servo motors; CNC programming; Case studies for manufacturing of tractor through industry visit

20. Mechanics of Tillage and Traction (FMP 408) 3(2+1)

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 performance of tillage tools. Introduction to traction and mechanics, off road traction and mobility, traction model, traction improvement, traction prediction, tyre size, tyre lug geometry and their effects, tyre testing, soil compaction and plant growth, variability and geo statistic, application of GIS in soil dynamics.

Practical: Measurement of static and dynamic soil parameters related to tillage; Measurement of soil parameters related to puddling and floatation; Measurement of draft for passive rotary and oscillating tools; Measurement of slip and sinkage under dry and wet soil conditions; Measurement of load and fuel consumption for different farm operations; Economics of weight transfer and tractor loading including placement and traction aids; Studies on tyres, tracks and treads under different conditions; Studies on compaction and number of operations.

21. Systems Engineering (MTH 401) 3(3+0)

System concepts. Requirements for a Linear programming problems. Mathematical formulation of Linear Programming problems and its Graphical solution. Response of systems. Computer as a tool in system analysis. Simplex method. Degeneracy and Duality in linear programming. Artificial variable techniques, Big M method and two phase methods. Mathematical models of physical systems. Modelling of Agricultural Systems and operations. Cost analysis. Transportation problems. Assignment problems. Waiting line problems. Project management by PERT/CPM. Resource scheduling.

Semester wise courses for B. Tech. in Agricultural Engineering

Semester – VIII:

Sl. No.	Subject	Course No.	Credit
1.	PROJECT - II	PRJ 451	3(0+3)
2.	Practical Training at Institution/University.	TRN 451	17(0+17)
3.	In Plant/Industrial Training-II	TRN 452	4 (0+4)

Total 24(0+24)

PROJECT-II: - Completion of project work (experiments, data analysis and interpretation of data) proposed in the course PRJ 401, technical report writing of the project work following standard format strictly as per the recommendation of the Faculty. Three (03) copies of hard bound project report are to be submitted on the day of final project presentation by the student.

In Plant/Industrial Training-II:-The student will undergo Practical Training of one (01) month duration at suitable training institutes/organizations/industries in 6^{th} semester of the degree programme. The students will be evaluated in this course based on training report submission, presentation and viva-voce.

Practical Training at Institution/University: - The students will be assigned a practical problem related to the core disciplines of Agricultural engineering to asses their technical skills in design, development, fabrication of equipments, models, tools, machineries or processing/post harvest value addition of food products. At the completion of the job the students will be evaluated based on the submission of a brief report followed by presentation and viva-voce.

* Tutorial class of two periods

Grand Total = (24+23+24+24+23+22+23+24) = 187 Credits