

Revised Course Structure for B-Tech Agricultural Engineering Applicable from 2009 Batch

SEMESTER – I

S. No.	Course Code	Course Title	L- T- P	Credits
1.	LNG 304	Professional Communication & Technical Writing	3- 0-0	3
2.	GPT 301	Moral & Value Education	2- 0 -0	2
3.	ME 303	Engineering Drawing	0- 0- 2	2
4.	EEE 301	Basic Electrical Engineering	2 -1- 1	4
5.	AGRN 403	Principles of Agriculture (PCM Group)	2- 0- 1	3
6.	ECE 301	Basic Electronics	2- 1- 1	4
7.	MAS 312	Elementary Mathematics (Ag. Group)	3- 0- 0	3
8.	PHY 312	Engineering Physics	3- 1- 1	5
9.	COMP 410	Computer and Languages	2- 1- 1	4

SEMESTER II

S. No.	Course Code	Course Title	L- T- P	Credits
1.	SES 401	Principles of Soil Science	2- 0- 1	3
2.	ME 304	Workshop Practice & Technology	2- 0- 2	4
3.	CE 401	Engineering Mechanics	3- 0- 0	3
4.	ME 413	CAD/CAM Machine Drawing & Computer Graphics	1- 0- 2	3
5.	MAS 411	Engineering Mathematics –I	3- 1- 0	4
6.	ME 408	Engineering Thermodynamics	2- 0- 1	3
7.	AGRN 301	Horticultural & Field Crops	2- 0-1	3
8.	CHEM 520	Engineering Chemistry	2- 0- 1	3

SEMESTER – III

S. No.	Course Code	Course Title	L- T- P	Credits
1.	FMP 302	Farm Implements	2-0-1	3
2.	CE 402	Surveying & Leveling	2-0-2	4
3.	MBGE 327	Introductory Biotechnology	3-0-0	3
4.	CE 408	Strength of Materials	2-1-0	3
5.	EEE 402	Electrical Machines	2-0-1	3
6.	EXT 301	Extension Education	2-0-1	3
7.	MAS 490	Engineering Mathematics -II	3-1-0	4
8.	MAS 511	Statistical Methods	2-0-1	3
9.	COMP 409	Database Management & Internet Applications	1-0-2	3

SEMESTER – IV

S. No.	Course Code	Course Title	L- T- P	Credits
1.	CE 406	Fluid Mechanics	3-0-1	4
2.	FMP 402	Farm Machinery	3-0-1	4
3.	SWLE 403	Engineering Hydrology	3-0-0	3
4.	APFE 504	Unit operation in Food Engg.	3-0-1	4

5.	CE	410	Soil Mechanics	2-1-0	3
6.	ME	503	Heat & Mass Transfer	3-0-1	4
7.	SES	503	Soil Physics	2-0-1	3
8.	ME	414	Theory of Machines	2-0-1	3
9.	SES	415	Environmental Studies – I	2-0-0	2

SEMESTER – V

S. No.	Course Code	Course Title	L- T- P	Credits
1	ME 502	Refrigeration and Air Conditioning	2-0-1	3
2.	CE 409	Building Materials and Structural Design	2-1-0	3
3.	ME 415	Machine Design	3-1-0	4
4.	ABM 502	Agri Business Management	3-0-0	3
5.	FMP 503	Field Operation and Maintenance of Tractors and Farm Machinery	1-0-2	3
6.	APFE 401	Engineering Properties of Biological Materials	2-0-1	3
7.	SWLE 404	Well & Pumps	2-0-1	3
8.	SES 416	Environmental Studies – II	2-0-0	2
9.	AET 400	Training – I	0-0-1	1

SEMESTER - VI

S. No.	Course Code	Course Title	L- T- P	Credits
1.	ECE 512	Instrumentation and Control Engineering	2-0-1	3
2.	MAS 512	Operation Research	3-0-0	3
3.	APFE 511	Post Harvest and Storage Engineering	3-0-1	4
4.	FMP 501	Tractors and Power Units	3-0-1	4
5.	SWLE 501	Soil and Water Conservation Engineering	2-0-1	3
6.	APFE 516	Crop Process Engineering	2-0-1	3
7	SWLE 502	Irrigation Engineering	3-0-1	4

SEMESTER - VII

S. No.	Course Code	Course Title	L- T- P	Credits
1.	FMP 502	Renewable Energy	2-0-1	3
2.	FMP 601	Farm Machinery Design and Testing	3-0-1	4
3.	SWLE 505	Drainage Engineering	2-0-1	3
4.	APFE 512	Dairy and Food Engineering	3-0-1	4
5.	AET 601	Entrepreneurship Development on Agro - Industries	3-0-0	3
6.	SWLE 503	Hydraulics and Design of Irrigation Systems	3-0-0	3
7.	SWLE 504	Soil and Water Conservation Structures	2-0-0	2
8.	AET 500	Training- II	0-0-1	1
9.	AET 580	Seminar –I	0-0-1	1
10.	AET 699 a	Project (Project Formulation)	0-0-3	3
11.	AET 600	Educational Tour/Field Visit	NC	

SEMESTER - VIII

S. No.	Course Code	Course Title	L- T- P	Credits
1.	SWLE	Elective – I Soil and Water Engineering (any one)	3-0-0	3
2.	FMP	Elective – II Farm Machinery & Power	3-0-0	3

		Engineering (any one)			
3.	APFE		Elective – III Agricultural Process & Food Engineering (any one)	3-0-0	3
4.	AET	680	Seminar -II	0-0-1	1
5.	AET	699 b	Project (Project Execution and Report)	0-0-7	7

ELECTIVE –I (Any one)

S. No.	Course Code	Course Title	L- T- P	Credits
1.	SWLE 601	Integrated Watershed Management	2-0-1	3
2.	SWLE 604	Economic Evaluation of Water Resource Projects	3-0-0	3
3.	SWLE 605	Water Laws & Policies	3-0-0	3
4.	SWLE 606	Minor Irrigation	2-0-1	3
5.	SWLE 607	GIS and Remote Sensing	2-0-1	3
6.	SWLE 610	Landscape Irrigation Design & Management	3-0-0	3
7.	SWLE 602	Water Harvesting and Ground Water Recharge	3-0-0	3
8.	SWLE 512	Wasteland Management	3-0-0	3
9.	SWLE 603	Operation, Maintenance & Economic Evaluation of Water Resource Projects	3-0-0	3
10.	SWLE 611	Water Quality Management	2-0-1	3
11.	SWLE 612	Reservoir & Pond Design	2-0-1	3
12.	SWLE 408	Environmental Engineering	3-0-0	3

ELECTIVE – II (Any one)

S. No.	Course Code	Course Title	L- T- P	Credits
1.	FMP 602	Human Factors Engineering	2-0-1	3
2.	FMP 603	Farm Machinery Management	3-0-0	3
3.	FMP 604	Fluid Machinery and Hydraulic Controls	3-0-0	3
4.	FMP 605	Tillage and Traction Engineering	2-0-1	3
5.	FMP 606	Manufacturing Processes of Agricultural Machinery	3-0-0	3
6.	FMP 607	Tractor Design & Testing	3-0-0	3
7.	FMP 608	System Engineering	3-0-0	3
8.	FMP 609	Agricultural Mechanisation	3-0-0	3

ELECTIVE – III (Any one)

S. No.	Course Code	Course Title	L- T- P	Credits
1.	APFE 603	Food Plant Operations Management	3-0-0	3
2.	APFE 606	Beverages Technology	3-0-0	3
3.	APFE 608	Advanced Techniques in Food Processing	2-0-1	3
4.	APFE 611	Food Packaging Technology	2-0-1	3
5.	APFE 602	Food Process Equipment Design	2-1-0	3
6.	APFE 614	Food Laws and Legislation	2-0-0	2
7.	APFE 615	Entrepreneurship in Food Industry	2-0-0	2
8.	APFE 508	Food Plant Sanitation & Waste Management	2-0-1	3
9.	APFE 601	Food Plant Design & Maintenance	2-1-0	3
10.	APFE 509	Fermented Food Products	2-0-1	3

of magnetic and dielectric materials; magnetic circuit, hysteresis and eddy current losses, two port network parameters, force acting on current carrying conductor in magnetic field, magnetic force due to electric current, statically and dynamically induced EMF, stored energy, force between parallel conductors, single phase transformer, construction principle, EMF equation, transformer efficiency.

Practical: Verification of Kirchhoff's laws, measurement of current voltage, frequency and power, determination of impedance and its components, three phase power measurements, electromagnetic relays and solenoids, calibration of energy meter with watt meter, no load and open circuit test of a transformer, efficiency of transformer, phasor diagrams of single phase circuits, relation between line and phase voltage and currents.

AGRN 403 Principles of Agriculture (PCM) group 3 (2-0-1)

Crop Classification, Cropping systems for major agro-ecological regions; crop ecosystem and strategies of crop production in tropical and sub-tropical regions; modern techniques of raising field and horticultural crops; tillage practices and soil management, seeds and seeding practices; scheduling of irrigation and fertilizers; plant protection measures; harvest and post harvest operations; dry land farming principles and practices; crop growth assessment and modeling.

Practical: identification of an acquaintance with seeds, plants, weeds and Agro-chemicals, testing of Germination, viability and vigour of seeds, estimation of agro-chemicals for field application, determination of tillage requirement for field preparations, Hydroponics, seeding and planting techniques and assessment of stand and establishment of field crops, Irrigation water measurement techniques, Biometrics observations of growth, yield and yield attributes, measurement of Leaf Area index, Determination of chlorophyll content in leaf, estimation of oil in different oil seed crops, Determination of N,P,K, in crops, testing quality of Crops

ECE 301 Basic Electronics 4 (2-1-1)

Introduction to signals, spectra, transducers, electronics and systems, p-n junction diodes, rectifiers – half-wave, full wave, capacitive filters, Zener diodes, power supply and voltage regulation; p-n-p and n-p-n transistors, transistor characteristics, transistor as an amplifier – CE, CB, CC; biasing and bias-stability, small-signal, equivalent Circuits, H-Parameter Model, Signal Handling Capacity, Frequency Response Of Amplifiers; Concepts Of Feedback Amplifiers, negative feedback, gain-bandwidth product, regenerative feedback and conditions for oscillation, oscillators; OP-AMPS and application of OP-AMPS; Field effect devices – JFET, MOSFET and their characteristics; SCRs, power amplifiers; Logic Gates; Flip – Flops and ICs.

Practical : Familiarity with electronic components and use of multimeters, Use of millivoltmeters, signal generators and oscilloscopes; Pulse and frequency response of R-C and C-R circuits; Half wave and full wave rectifiers, Rectification with capacitor filters and Zener diodes; Transistors, CE amplifier, biasing condition, gain and signal handling capacity; Measurement of frequency response and bandwidth of a CE amplifier; Characteristics of unity gain amplifier and summing circuits; Characteristics of OP-Amp integrators and differentiator; Characteristics of digital logic gates; Studies Flip-Flops, shift registers and counters. Characteristics of OP-Amps, inverting & non inverting amplifiers.

MAS 312**Elementary Mathematics (Ag Group)****3 (3-0-0)**

Algebra: Theory of quadratic equations i.e. $(ax^2 + bx + c = 0)$, Binomial theorem (for positive integral index only). Uses of Natural and Common Logarithms, Exponential series, Partial Fractions, Determinants (of order three only), Theory of Matrices (Addition, Subtraction), Product of Matrices, Transpose, Elementary idea of following adjoint, Inverse of matrices by adjoint method, Solution of liner equations, Solution of inequalities, Permutation and combination.

Trigonometry: Trigonometry functions, addition and subtraction formula, Double and half angle formula, Laws of sines and cosines, Solution of triangles, Height and distances, Real and complex numbers, Hyperbolic trigonometric functions, De Moivre's theorem.

Coordinate Geometry: Distance between two points, Area of triangles, Straight lines (Parallel and at right angles)

Calculus: Elementary Differentiation and Integration.

PHY 312**Engineering Physics****5 (3-1-1)**

Surface tension: Angle of contact, Excess of pressure inside a spherical surface, Capillary rise, Determination of surface tension by Jaeger's methods.

Viscosity: Streamline and turbulent motion, Coefficient of viscosity, Critical velocity, Poiseuille's equation for flow of liquid through a tube, Viscometer.

Optics: Interference, Thin films, Testing of Optical plainness of surfaces. Young's double slit experiment – Coherent sources, Intensity in Young's experiments, Interference in thin films, Newton's ring and Michelson interferometer. Diffraction Fraunhofer diffraction at single slit, Diffraction at a circular aperture, Diffraction at double slit, Diffraction Gratings, Resolving and dispersive power of a grating.

Polarization: Production and detection of circularly & elliptically polarized light. Quarter and half wave plates, Optical activity, Specific rotation, Lurent's half shade polarimeter, Determination of specific rotation and strength of sugar solution.

Ultra Sonics: Production, application in ranging, Cleaning and drilling.

Practical : Production and measurements of vacuum. Mechanical pumps (Rotary vacuum pump) Diffusion and condensation pumps, Gettesr measurement: Manometer, Meclod gauge, Piram gauge. Measurement of temperature: Thermo e.m.f., Measurement of thermo e.m.f. by potentiometer, Higher temperature measurement by using pyrometers and resistance thermometer.

COMP 410**Computer & Languages****4 (2-1-1)**

Details of computer organization and peripherals, types of computers, hardware –software, working in DOS and Window environment, networking, algorithms and flow charts, programme development, arithmetic expressions, programme compilation, debugging and testing. Concept of structured programming, subroutines and functions. Computer viruses, solution to engineering problems using BASIC / FORTRAN. Future trends and in computer laws and piracy.

Practical : Study of computer components, computer practice of DOS commands, study of BASIC using READ, DATA, PRINT statements etc., numerical integration and differentiation using BASIC language, BASIC programme for 't' test, BASIC programme for random number generation in different ranges, FORTRAN programme- READ, WRITE AND PRINT Statement, free Format and Formatted INPUT AND OUTPUT Statements, solution of Quadratic equation using FORTRAN language, use of subroutines in the main programmes, use of function sub programmes in the main programmes, Runge- Kutta method, Trapezoidal – Simpson's rule.

SEMESTER – II

SES 401 Principles of Soil Science 3 (2-0-1)

Course Objective – To develop basic understanding in students about soil forming processes and soil as natural body/medium for storage and movement of water, gases, heat, nutrients. To develop student understanding of the general physical and chemical properties of soil.

Course Content – Soil as three-phase system, Definition of soil, soil forming rocks and minerals, weathering of rocks and minerals, soil formation processes, factors of soil formation, soil profile and its development.

Soil Physical Properties-Texture, Textural classification of soils, Stoke's law and its limitations, Soil structure, Formation and types of soil structure, Bulk Density, Particle density, Porosity, Types of Soil Water, Soil Moisture Tension/Water potential, Saturation, Soil water movement, Soil Temperature, Soil Air, Aeration and its importance.

Soil Chemical Properties , Soil Reaction-Soil pH, Saline, Saline Alkali, Alkali Soils and their management, Colloidal Properties of the Soil- Soil organic matter and Humus formation ; Clay minerals: Colloidal properties, 1:1, 2:1 lattice structures; Cation exchange properties of soils as contributed by organic and inorganic colloids. Diffuse Double Layer, Stern layer theory, Flocculation and dispersion; Soil Classification – Soil Taxonomic orders.

Practical:

Techniques of soil sampling, preparation of soil samples for analysis. Determination of Bulk Density and particle density of soil, soil moisture content. Determination of Soil Texture. Study of soil profile, Identification of Rocks and Minerals. Si O₂ determination, HCl extraction of soil. Gravimetric determination of sulphate. Organic matter / Carbon determination. Determination of cation exchange capacity of soil. Determination of Ca, Phosphorus, and Iron Nitrogen, Potassium, Soil pH, Gypsum requirement, lime requirement of soils, Electrical conductivity, SAR. Determination of water-soluble anions chlorides, carbonates, bicarbonates.

ME 304 Workshop Practice & Technology 4 (2-0-2)

General: Workshop terminology, ferrous and non ferrous metals, steel and alloy steels, light alloys and non ferrous heavy metals, heat treatment, case hardening, corrosions, Plastics, glue, grease, paint, varnish and lacquers.

Carpentry: Timber classification, defects in timber, description and use of tools in carpentry.

Smithy: Nature of work in smith's furnace tools and their uses, safety and precautions in smithy, jigs and fixtures, hot and cold working of metals, forging drawing and spinning Fitting: Description and use of files, chisels, hacksaw, vices, hammers and other measuring marking tools, precision measuring tools, dial gauges and inspection gauges.

Machine Job: Classification and description of lathe machine, milling, drilling and grinding machine, special purpose machines- Turret and Capstan –Lathes, gear cutting machines.

Welding Job: Types of welding oxyacetylene gas welding, electric arc welding, argon arc welding, MIG and TIG welding, resistance welding, brazing and soldering, use of fluxes.

Sheet metal shop- Description and uses of tools used in sheet metal shops, different joints, riveting.

Practical: Sawing and simple joints, planing; Chipping marking and filing; Knurling, centering, drilling and threading, etc.; Forging operation; Welding joint preparation; Metal arc welding and gas welding practice; Riveting operation for lap joint.

CE 401 Engineering Mechanics 3 (3-0-0)

Introduction to mechanics and SI unit, review of vector algebra and important vectors equivalent force

impulse & Reaction turbine, Study of steam engine model, Study and working of two stroke petrol engine, Study and working of four stroke petrol engine, Determination of indicated H.P. of I.C. Engine by Morse Test, Study and Working of two stroke Diesel Engine, Study and working of four stroke Diesel engine, Study of Ignition system of I.C. Engine, Study of Braking system of any vehicle.

AGRN 301

Horticultural & Field Crops

3 (2-0-1)

Agronomy:

Farm crops, Cultivation of wheat, Paddy, Jowar, Cotton, Maize, Groundnut, Potato, and Sugarcane with reference to its varieties. Area of growing, sowing time, Seed rate, Method of sowing, manuring irrigation and water requirements. Harvesting, Threshing and yields. Crop rotation, Soil, Soil formation, Classification (sand, loam, silt, clay), Soil Characteristics, Manuring and its importance, Study of Gobar, Compost and Green manure.

Agronomy Practical :

Identification of crops being grown at the crop Research Farm. Identification of rabi season weeds. Calculation of seed rate, fertilizer management, yield estimated in crops and practical assessment of plant growth in field crops.

Horticulture:

Importance of fruit and vegetable in diet, scope and importance of fruit and vegetable industry. A general survey of fruits grown in India.

Planting plants: Their merits and demerits, preliminary operation before planting.

Temperature relation: Temperature as part of climate, influence of temperature on plants, freeze and frost and their control.

Water relation: Water absorption and movement in plant, methods of irrigation systems for fruits and vegetables, their merits and demerits.

Light relation: Role of light in seed germination, photoperiodism, and light source of radiant energy.

Soil: Essential elements and their role, methods for correcting deficiency and excess.

Nutrition: Essential elements and their role, methods for correcting deficiency and excess.

Propagation: Sexual propagation, cuttage, layerage and graftage. Raising and sectioning of root stock.

Pruning and growth control: System and methods of training fruit trees pruning principles and method pruning tools and their material.

Marketing storage of horticulture produce, preparation for marketing.

Cultivation of Cauliflower, Cabbage, Onion, Bottle gourd, Carrot, Pea, Tomato, Banana, Oranges, Mango and Guava with reference to its varieties, sowing time, seed rate, method of sowing, manuring, irrigation and water requirements, harvesting threshing and yield.

Horticulture Practical:

Different techniques of propagation; Use of plating board; pruning and training tools and implements; spraying of nutrients to overcoming deficiencies in the fruit plants .

CHEM 520

Engineering Chemistry

3 (2-0-1)

Water-Hardness, determination of hardness by compleximetric (EDTA) method, degree of hardness, Chloride dissolved oxygen, dissolved carbondioxide and sulphate, calorimetric methods for the determination of pH, control of pH of water used in industry.

Chemical Fuels – Classification of fuels, solid fuels, coal-origin and its classification, proximate and ultimate analysis of coal, significance of constituents, Gross and Net Calorific Values, Determination of Calorific value by Bomb Calorimeter.

Liquid Fuels – Advantages, Petroleum – origin, Classification, refining of petrol, Gasoline, Knocking –

Octane Number, Chemical Structure and Knocking – Anti Knock agents, Cracking
 Gaseous Fuels – Advantages, manufacture, composition and calorific value of coal gas and oil gas.
 Determination of Calorific Value of gas by Junker's Calorimeter. Flue gas analysis by Orsat apparatus,
 Classification based on combustion.
 Corrosion – Definition and its significance theories of corrosion, Galvanic cell and concentration cell.
 Pitting and Stress Corrosion, Protection of corrosion. Use of inhibitors and passivation. Alloying,
 protective coating – metallic, Inorganic and organic.
 Refractories – Definitions, properties, classification. Properties of Silica and Fireclays Refractories.
 Glass-Preparation, Varieties and uses.
 Plastics – Types of plastics, Compounding of plastics and their fabrication.
 Rubber- Natural rubber, vulcanization, elastomers and their uses.
 Fibres – Natural and synthetic fibers and use of Nylon , Terylene and Rayon.
 Lubricants – Classification, types of lubrication, properties and tests (Viscosity and viscosity index.
 Flash and Fire point, Cloud and pour point, Emulsification)
 Chemical Kinetics – Order and molecularity of reaction, first and second order reaction. Derivation of
 equations for first order and second order reactions. Determination of order of reaction. Energy of
 activation and Arrhenus equation. Numericals of first and second order reactions.
 Cement- Manufacture of Portland cement, vertical shift kiln technology, Chemistry of setting &
 hardening.
 Electro Chemistry – Specific, molecular and equivalent conductivity. Effect of dilution on conductivity.
 Determination of conductivity. E.M.F and its measurements. Polarization and overvoltages.

Practical: Determination of viscosity of oil, Determination of calorific value of a solid or liquid fuel by
 bomb calorimeter. Determination of flash point and fire point, Analysis of flue gas by orsat apparatus,
 Determination of calorific value of a gas, Determination of sodium and potassium in water by flame
 photometer, Determination of temporary and permanent hardness by EDT method, Determination of
 carbonate and non – carbonate hardness by soda reagent method, Estimation of hydroxyl ion and
 carbonate ions in a mixture or both in water samples, Determination of copper sulphate iodometrically,
 Determination of potassium dichromate using potassium ferrocyanide as an external indicator,
 Determination of potassium dichromate using diphenylamine as a internal indicator, Estimation of iron
 in plane carbon steel, Estimation of available chlorine in bleaching powder sample, Determination of
 Bod & COD values of a water sample, Analysis of (Any three) Brass, Cement, Iron ore, Pyrolusite,
 Conductor wire, Proximate analysis of coal, Sample of NaCl of reaction. Energy of activation and
 Arrhenus equation. Numericals of first and second order reactions.

SEMESTER – III

FMP 302

Farm Implements

3 (2-0-1)

Status and scope Farm mechanization, Classification of farm machines, Bullock drawn primary and
 secondary tillage implements. Method of ploughing. Manually and Bullock drawn sowing, planting and
 transplanting equipments. Manually operated plant protection equipments: Sprayers and Dusters.
 Manually operated weed control and intercultural tools. Manual tools for harvesting. Bullock drawn
 manure spreader. Manual and bullock operated sugarcane crusher. Manual and Bullock operated chaff
 cutter. Paddle operated paddy thresher. Cost analysis.

Practical: Practical study of bullock drawn ploughs & harrows. Study of different animal drawn
 seeding equipments & machineries. Study of manual & animal drawn harvesters. Study of manual
 method of threshing and animal operated threshers.

CE 402 **Surveying and Leveling** **4 (2-0-2)**

Measurement of distance, principle and methods of chain surveying, prismatic compass and chain traversing, theodolite traversing, plane table surveying including two-point and three-point problems, leveling and contouring, measurement of areas and volumes, principles of hydrographic surveying and aerial surveying and their application to agricultural engineering.

Practical:

Handling of chain and chain accessories, offsetting, acquaintance with field book; Ranging out surveying line and plotting chain survey; Triangulation by chain and offsetting for details for preparation of map of a small area; Plotting of the field book reading for preparation of map acquaintance with symbols of different objects used in maps and scale of map; Setting up of prismatic compass and measurements of angles; Traversing of a small area with chains and prismatic compass and offsetting for details; Plotting of the above map; Setting up off a 20'' accuracy transit Theodolite and measurement of horizontal angles and verticals angle; Setting up off a plain table and off setting by intersection method; Plain table traversing (5 sides); Setting up off a dumpy level and exercise in fly leveling and reciprocal leveling; demonstration of modern equipment- Theomat, Distomat and Automatic levels.

MBGE 327 **Introductory Bio-technology** **3 (3-0-0)**

Principles of plant growth and reproduction; cell structure, cell division and cell cycle; structure of nucleic acids, transcription and translation; metabolic pathways; respiration photosynthesis, N₂ – fixation; plant tissue culture; cell tissue and organ culture, protoplasm culture and somatic hybridization, micro-propagation, mass production technology and automation; secondary metabolite production; recombinant DNA technology and its application; environmental biotechnology.

CE 408 **Strength of Materials** **3 (2-1-0)**

Concept of stress, normal and shearing stress in axially-loaded members, factors of safety and introduction to design the strength, concepts of strains, normal and shearing strains, stress- strain relationship, generalized Hooke's law, strain compatibility in two dimensions and application to isotropic materials, plane stress and plain strain; Poisson's ratio, stress –strain diagrams for uniaxial loading deformation of axially loaded members and statically indeterminate problems torsion's of circular shafts: stress and deflections in closed coiled and helical springs subjected to axial forces; members subjected to flexural loads; reactions for statically determinate beams; relationship between loads, shearing force and bending moment; shear force and bending stresses in beams; shearing stresses in beam; members subjected to combined loads; transformation of plain stresses and strain; principal stresses and principal plains; principal strains, Mohr's circle of stresses and strain , principal stresses in 3D; relationship between elastic constant; Strain rosettes; principal stresses for strain measurements; combine torsion and bending; investigation of stress at a point; pressure vessels; byaxial stresses; yield theories; principles of design for strength; deflections of beams; direct integration method, moment area method.

EEE 402 **Electrical Machines** **3 (2-0-1)**

D.C Machines: Constructional features and principles of operation of shunt, series and compound generators and motors including EMF equation and armature reaction; Performance characteristics of generators and motors, starting, speed control and braking of motors, 2- quadrant and 4 – quadrant operation of motors; Choice of D.C. motors for different applications; Losses of efficiency.

and X² tests. Distribution: Normal, Binomial and Poisson distribution, confidence interval. Analysis of variance; definition, assumption, one-way and two way classification with one observation per cell, probability theory.

Practical: Computation of Arithmetic, weighted, geometric, harmonic means, mean distribution, standard deviation, coefficient of variation, fitting of data, Problems on Normal, Binomial and Poisson distributions. Tests of significance. Problems on analysis of variance.

COMP 409 Database Management & Internet Applications 2 (1-0-1)

Basic database concepts, introduction to RDBMS, SQL Commands, Data constraints, Joins, set operations, working with forms, Basics of HTML, developing web pages using meta tags, dynamic pages using Java scripts, connectivity with RDBMS, Project. Basic database concepts; Introduction to RDBMS; SQL Commands DDL, DML; Select command, Joins and functions; Group functions, Set functions; Working with Forms; Basic of HTML; Development of Web pages using meta tags; Dynamic pages using Java Scripts; Connectivity of Web pages with databases; Project.

SEMESTER – IV

CE 406 Fluid Mechanics 4 (3-0-1)

Definition and properties of fluids. Units of measurement, fluid statics: pressure at a point and its measurement, fluid static force on submerged surface, buoyancy, condition of floating and stability of submerged and floating bodies.

Kinematics of fluids: Lagrangian and Eulerian description of fluid motion, stream lines, path lines, streak lines, types of fluid flow: translation, rotation, circulation and vorticity; stream function, velocity potential and flow net; discharge; system, control volume and cross section; stress-strain rate relationship, linear and angular momentum theorems and application; some exact solutions of Navier-Stokes equation.

Dynamics of third: Transport theorem, conservation laws, equation of continuity, Euler's equation of motion, Bernoulli's equation, viscous flow.

Dimensional Analysis & Similitude: Rayleigh's method & Buckingham's Pi theorem, types of similitudes, dimensional analysis, dimensionless numbers.

Internal flow: Laminar & turbulent flow in pipes, general equation for head loss-Darcy-Weisbach and Fanning's equations, Moody's diagram, energy losses through pipe fittings, flow through network of pipes.

Non-Newtonian fluid flow:- Power law representation of shear stress-shear rate relationship, measurement of flow behaviour index and consistency coefficient, generalized viscosity coefficient.

Concept of boundary layer, hydrodynamic forces on immersed bodies: drag & lift; flow through orifices, mouthpieces and over weirs & notches; flow in open channels.

Practical: Study of pressure measuring devices, Relationship between depth of liquid and pressure exerted by it, Determination of metacentric height of floating vessels, Determination of pressure drop flow rate relationship for flow of air through packed bed and fluidization velocity, Determination of flow pattern, port arrangement and pressure drop in a plate heat exchanger, Verification of Bernoulli's theorem, Demonstration of laminar and turbulent flows, Determination of head loss through pipes and pipe fittings. Determination of coefficient of discharge for a venturimeter, Determination of orifice meter coefficient, Calibration of a notch, Measurement of non-Newtonian parameters of liquid foods, Determination of forces on submerged bodies, Flow visualization using smoke in a transparent tube to demonstrate path line, streak line, laminar and turbulent flows, Experiments using water table to demonstrate various flow phenomena, Measurement of viscosity surface tension of liquids, Demonstration of momentum theorem using impulse and reaction turbines, Estimation and measurement of flow rate through single screw extruder.

FMP 402 Farm Machinery 4 (3-0-1)

Status and scope of farm mechanization, Classification, constructional details, principles of operation of manually operated, animal drawn and power operated implements and machinery used in crop production viz. primary and secondary tillage implements, puddlers, intercultural implement, seeding, planting and fertilizer application equipment, plant protection equipment. Crop harvesting and threshing equipment, chaff cutters and sugarcane crushers. Hitching of implements. Safety in farm machinery. Performance evaluation, selection and cost analysis.

Practical: Practical study of primary tillage and secondary tillage implements. Constructional and functional study of different types of seed-drill, Calibration of seed drills. Study of sprayers & dusters, self-propelled rice transplanter, different types of power operated reapers and threshers.

SWLE 403 Engineering Hydrology 3 (3-0-0)

Weather and hydrology, Forms of precipitations; Measurements and estimations, Evaporation & transpiration: Factor affecting, Measurements and estimation, Stream flow measurement: Measurement of stage & velocity, Stage discharge relationship, Runoff: Introduction to hydrograph, runoff characteristics of streams, yield (annual runoff volume), flow duration curve, flow mass curve. Hydrograph: Factors affecting flood hydrograph, Components of hydrograph, Base flow separation, Effective rainfall, Unit hydrograph, Synthetic & Instantaneous unit hydrograph, Flood routing: Basic equations and Method of flood routing, Hydrologic channel routing, Clark method for instantaneous unit hydrograph, Nash conceptual model.

APFE 504 Unit Operation in Food Engineering 4 (3-0-1)

Principles of fluid flow, heat transfer, heat exchanger, ERH & Water activity, Evaporation, Distillation, Drying, Dehydration. Types of dryers, Material handling equipment, Size reduction, Energy requirement in Size Reduction, Sieve analysis, Mixing, Kneading, Blending, Homogenization, Size Separation, Sedimentation, Extraction, Leaching, Crystallization, Thermal Processing, Refrigeration principles, Cooling, freezing, thawing of food materials. Irradiation, Absorption and Adsorption, Mechanical Cleaning, Grading, Sorting, Filtration, Membranic Separation, Emulsification.

Practical: Measurement of fluid flow, Measurement of moisture content &ERH, Study of conduction, convection and radiation, Heat exchanger, Elevator and conveyors, Size reduction equipment, Sieve analysis, Mixing equipments, Drying rate calculations, Calculation of refrigeration load etc.

CE 410 Soil Mechanics 3 (2-1-0)

Engineering properties of Soil, Soil Hydraulic, Stress distribution, Compressibility, Shear strength, Earth Pressure, Rankine theory, Coulombs wedge theory, Stability of slopes, Stability analysis of finite & infinite slopes, Taylor's stability nos. and stability curves, Bishops methods of stability analysis.

Bearing Capacity: Rankines analysis, Terzaghis analysis, Effect of water table on bearing capacity, Shallow foundations; Types of foundation, spread footing, well foundation, shape of wells and components, Depth of well, foundation and bearing capacity, forces acting on a well foundation, analysis of well foundation, well sinking, pile and machine foundation.

Introductory concepts on conduction, convection and radiation.

Conduction Fourier's Law, thermal conductivity dependence on temperature and pressure in fluids, heat conduction through composite walls, optimum thickness of insulation, and general conduction equation under unsteady state. Transient numerical method for unsteady state conduction in simple geometrical shape. E.g. slab, cylinder and sphere.

Convection free and forced convection, Newton's Law of cooling, film coefficient, correlation of Nusselt number, Prandtl number and Grashof number in natural convection systems including other empirical relations. Combined free and forced convection.

Radiation- Stefan-Boltzmann law, emissivity, mechanism of radiation heat transfer in systems including solar radiation, collectors. Heat transfer analysis involving conduction, convection and radiation by network.

Heat Exchange: Overall heat transfer coefficient, fouling factors, log mean temperature difference. Heat exchange mechanism in various types of heat exchanger e.g. tubular, extended surface and plate heat exchangers, effectiveness – NTU relationship.

Mass Transfer – Steady state molecular diffusion in fluids at rest and in laminar flow – Fick's Law, mass transfer coefficients. Mass – heat – momentum transfer analogies. Unsteady-state diffusion. Diffusion in solids. Inter phase mass transfer.

Practicals: Determination of thermal conductivity of a powder and insulating material under steady-state using two slab guarded hot plate method, Determination of thermal conductivity and thermal diffusivity of a food, Determination of specific heat using differential scanning calorimeter (DSC), Measurement of heat transfer coefficient of air under free and forced convection using heat and mass transfer analogy, Determination of overall heat transfer coefficient in an agitated vessel, Determination of overall heat transfer coefficient of a boiling liquid, Determination of effect of packing on heat transfer in packed beds, Determination of overall heat transfer coefficient in parallel-flow and counter-flow heat exchangers, Measurement of emissivity of a surface, Study of plate heat exchanger, Study of heat transfer from pin/tin, Study on boiling heat transfer and measurement of critical heat flux, Study of heat transfer in a fluidized bed, Determination of mass diffusivity by Winkelmann method, Generation of equilibrium data for mass transfer operations.

General physical characteristics of soil, soil as a dispersed three phase system, volume and mass relationships of soil constituents, soil profile, texture, particle size distribution, specific surface and soil classes, nature and behavior of clay, soil structure of aggregation, soil water content and potential, measurements of soil water, flow water in saturated and unsaturated soils, soil air and aeration, soil temperature and heat flow, soil compaction and consolidation.

Measurement of soil physical characteristics, soil water content, soil water potential, soil moisture characteristic curve, infiltration, hydraulic conductivity and soil composition.

Practical: Volume and mass relationship of soil constituents (problems and determination of dry Bulk density, particle density), Effect of concentration of ions and types of cations on physical properties of soils, Determination of soil compactibility, Determination of consistency, Determination of soil compaction – root growth, Determination of Soil-Water characteristic curve, Determination of pore size distribution. Measurement of soil water content, Determination of saturated hydraulic conductivity using first law of moisture flow – Darcy's Law, Determination of water flow in unsaturated soil using second law of moisture flow, Infiltration rate determination, Determination of upper and lower plastic limits, Determination of Attenberg's constant.

Theory: 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 masses.

Practical: Demonstration in mechanisms study using models; Analysis of 4-bar mechanism, slider 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 Epicyclic 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 planes.

SES 415**Environmental Studies – I****2 (2-0-0)**

Definition, Scope and Importance. Ecosystem, concept of an ecosystem, structure and function of an ecosystem, Producer, consumer and decomposers, Energy flow in the ecosystem, Ecological succession, Food chains, food webs and ecological pyramids, Introduction, types, Characteristic features, structures and function of the following ecosystems: forest ecosystem, grassland ecosystem, desert ecosystem and aquatic ecosystem.

Social Issues and the Environment: from unsustainable to sustainable development, urban problems related to energy, water conservation, rain water harvesting, watershed management, resettlement and rehabilitation of people; its problem and concerns, Case studies. Environmental ethics, Climatic change, wasteland reclamation, consumerism and waste products. Environmental Protection Act. Air (Prevention and control of pollution) act. Issues involved in enforcement of environmental legislation. Public awareness.

Practical: Visit of different polluted sites to assess their effect on pollution, monitoring of pollutant in ecosystem. Study of simple ecosystem- ponds, rivers, hill slopes. Study of common plants, insects, (Herbarium file/ insect box) Visit of local polluted site- urban/rural/agricultural/ industrial. To study the different purification of industrial effluents and wastes.

SEMESTER – V

ME 502

Refrigeration and Air Conditioning

3 (2-0-1)

Thermodynamic cycles, mechanical vapour compression refrigeration, properties of refrigerants, thermodynamic cycle, calculations of single stage saturation and actual cycles, two stage cycles and cascade refrigeration system, heat pump.

Compressors, expansion valves, evaporators and condensers, absorption system of refrigeration, ice manufacture, air conditioning, principles of psychrometry, psychrometric processes, air conditioning, comfort chart and effective temperature and respiration heat, cooling, load calculations and design of cold storage's, conveying and distribution of processed air, air conditioning controls.

Practical : Study of various types of compressors, Study of household refrigerator and window air conditioner, Determination of volumetric efficiency of a reciprocating compressor, Determination of coefficient of performance of a vapor compression refrigeration system and absorption system, Determination of bypass factor, apparatus dew point and COP of an air-conditioning system, Determination of range approach and efficiency of a cooling tower, Determination of efficiency of an evaporative cooling washer, Determination of freezing time of food products, Determination of heat transfer coefficient inside a cold storage or refrigerator, Determination of thermal conductivity of various insulating materials.

CE 409

Building Materials & Structural Design

3 (2-1-0)

Steel and its structural properties, Riveted and welded connections, Design of sections for tensions, Compression and bending including built-up sections, Grillage foundations, Roof trusses, Plate and lattice girders, Industrial buildings, Indian standard code. Introduction to I.S. code for practice for R.C. design, Design of two- way slabs, Retaining walls, Continuous beams, Water tanks etc. IRC bridge loadings – load distribution on bridge girders.

Design of Masonry and Timber Structures. Working Stress Design Method: Assumption, distribution of stresses on the cross section in bending transformed area, analysis and design of rectangular singly and doubly reinforced section, T and L sections.

Limit State Design Method: Assumptions, distribution of stresses on the cross section in bending Analysis and design of a rectangular singly & doubly reinforced Sec., T and L Sections.

ME 415

Machine Design

4 (3-1-0)

Materials of construction and their properties. Stresses in elementary machine parts, metal fits and tolerance, design of machine members subjected to variable loads, machine vibrations, critical speeds of shafts, power transmission shafting, coupling design, keys, pins and splines, power screw and threaded fasteners, bolt loading, clutches and brake designs, springs, different types of gears, rolling bearings, chain and belt drives, pulley and fly wheels.

ABM 502

Agri Business Management

3 (3-0-0)

Definition, History, function productive system, operations, decisions, decision frame work, produces of series & goods critical themes, operation strategy, model, objectives, types External factor, international operations, rescued operations, stages, new production introductions, new product development, technology development, quality function development, Value analysis, modular design.

Quality management, quality control and improvement, process selection, service operation design, choice of technology, layout of facilities, forecasting.

FMP 503 **Field Operation and Maintenance of Tractors and Farm Machinery** **3 (1-0-2)**

Theory : 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: 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.

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.

APFE 401 **Engineering Properties of Biological Materials** **3 (2-0-1)**

Engineering properties of agricultural and food materials. Concept of rheology, Rheological characteristics of biological materials, Newtonian and non-Newtonian, products. Thermal, electrical and optical properties of food materials. Application of engineering properties in designing of food process equipment.

Determination of roundness, sphericity of fruits and vegetables, Effect of moisture on frictional properties and specific gravity of grains, Study of elastic –plastic behavior, relaxation behavior and textural properties of selected food materials, Viscosity measurement of fluid foods and thermal properties of fluid foods.

Practical: Identification of different shapes of Biological materials based on standard chart, Principle & working of small dimension measuring instruments, Determination of Roundness & Roundness ration of materials, Determination of volume & sp. Gravity, Determination of sphericity of Grains, Fruits & Use, Determination of Bulk density & True density of small & large objects, Determination of angle of repose, Determination of leaf surface area a) Tracing & cutting method b) Tracing & Counting method, Determination of Egg Surface Area, Determination of Terminal velocity of grain

SWLE 404 **Well & Pumps** **3 (2-0-1)**

Aquifers – type and characteristics; evaluation of aquifer properties; ground water investigation, ground water movement and well hydraulics, ground water recharging; well drilling and construction methods; selection and installation of well screen; design of gravel pack; development and completion of water wells. Water resource evaluation.

Indigenous water lifts, classification of pumps; reciprocating pump and its working principle; air vessel, working principle of centrifugal pump; specific speed; characteristics curves; efficiencies; cavitation; net positive suction head, pump selection; working principle of jet, axil, air lift, submersible, mixed flow pumps and turbines, pump troubles – causes an remedies.

SES 416 Environmental Studies - II 2 (2-0-0)

Definition, Scope and Importance. Ecosystem, concept of an ecosystem, structure and function of an ecosystem, Producer, consumer and decomposes, Energy flow in the ecosystem, Ecological succession, Food chains, food webs and ecological pyramids, Introduction, types, Characteristic features, structures and function of the following ecosystems: forest ecosystem, grassland ecosystem, desert ecosystem and aquatic ecosystem.

Social Issues and the Environment: from unsustainable to sustainable development, urban problems related to energy, water conservation, rain water harvesting, watershed management, resettlement and rehabilitation of people; its problem and concerns, Case studies. Environmental ethics, Climatic change, wasteland reclamation, consumerism and waste products. Environmental Protection Act. Air (Prevention and control of pollution) act. Issues involved in enforcement of environmental legislation. Public awareness.

Practical: Visit of different polluted sites to assess their effect on pollution, monitoring of pollutant in ecosystem. Study of simple ecosystem- ponds, rivers, hill slopes. Study of common plants, insects, (Herbarium file/ insect box) Visit of local polluted site- urban/rural/agricultural/ industrial. To study the different purification of industrial effluents and wastes.

AET 400 Training – I 1 (0-0-1)

SEMESTER – VI

ECE 512 Instrumentation & Control Engineering 3 (2-0-1)

Measurement system and error analysis, measurement of level, flow, temperature, strain pressure, vacuum, force, torque, power, displacement, vibration, acceleration, pH, colour viscosity, surface tension and composition. Indicating recording instruments, digital displays, transmitting and telemetering devices.

Introduction to control system- Feedback and feed forward control strategies, block diagrams, Laplace and inverse Laplace transforms mathematics models of physical systems, transfer functions steady state analysis, dynamics of first and second order

systems. Mode of control and generation of control action; P. PI and PID control elements and value positioners, frequency response and root locus analysis. Stability and quality of overall control.

Electronic, pneumatic and hydraulic control systems and their application in farm machinery, food processing industry, aquaculture and their applications milk processing plants.

Practical: Calibration of Bourdon pressure gauge; Dynamic calibration of different types of thermometers, Determination of time constants of thermometers and thermocouples. Calibration of differential pressure transmitters; Calibration of velometer and hot wire anemometer; Speed measurement using non-contact type sensors; Determination of discharge coefficient using morificemeter and venturimeter; use and calibration of rotameter, pH meter, conductivity meter and viscometer; Static calibration of flapper nozzle assembly; Calibration of pneumatic P, PI and PID controllers; Study and calibration of control valves; Cascade control of level and flow/temperature and flow.

MAS 512**Operation Research****3 (3-0-0)**

OR definitions; principle components of decision problems – scope in agricultural and food engineering; principles of modeling; linear programming – concepts, graphical and algebraic solution, simplex method, revised simplex method, duality theory, post-optimality analysis; transportation and assignment models; computer applications to LP, queuing theory; project scheduling and management by PERT – CPM, integer programming; non linear programming – Fibonacci and Golden Section Search; Lagrange Multipliers and Kuhn-Tucker Conditions; introduction to dynamic programming and simulation

APFE 511**Post Harvest and Storage Engineering****4 (3-0-1)**

Threshing machines- design, principles, operations, maintenance and testing, winnovers, cleaners and graders & separators, Design principles, operation, maintenance and testing. Dehuskers, shellers, hullers, polishers, Grinders – Design Principles, operation, maintenance and testing. Drying of farm crops – principles of drying, EMC Drying curves, thin layer drying, fluidized bed drying, batch drying. Psychrometry-Properties of air & water vapour mixture. Dryers – Types, design principles, operation, maintenance and testing. Storage bins – design criteria, operation, maintenance, aeration and moisture migration in storage bins, detection and control of fungal and microbial insects and pests growth in the stored produce, storage technologies-control atmosphere storage, modified atmosphere storage, cover and plinth storage, hypobaric storage. Retail storage packaging – Nitrogen packaging, CO₂ packaging, vacuum packaging, retortable packaging.

Practical: Determination of moisture content of Farm produce by direct and indirect methods, Size reduction and determination of Bond's energy constant for grains, Determination of milling quality of paddy, Determination of milling quality of wheat, Sieve analysis of grain milling products, Parboiling of paddy, Performance of a thresher, cleaner and girder, Determination of shelling efficiency of a rice dehusker, Performance of a rice polisher, Evaluation of thermal efficiency and heat utilization factor in a grain dryer, Performance of an oil expeller, Rice and flour mills layout, Fringingraphy for dough development of wheat flour.

FMP 501**Tractors and Power Units****4 (3-0-1)**

Tractor development, tractor types, trends in tractor design. Power Units of tractors. Friction clutches and brakes. Power train, Transmission gears, types of high and low gear transmission. Differential, power-take-off and final drive. Tractor hydraulic components, properties of hydraulic fluid, position and draft control systems. Mechanical and power steering. Traction model, weight transfer, 2WD, 4WD, tread design. Traction mechanism, tyre size, load inflation pressure relationships, lug spacing and ply rating. Static equilibrium force analysis, maximum achievable drawbar pull. Tractor longitudinal and lateral stability, center of gravity determination. Operator exposure to noise, vibration, heat, cold and dust. Roll over protection for wheeled tractors, operator safety. Tractor testing and reliability, Tractor power costs estimation, tractor service life. Standards for tractors.

Practicals: Study of agricultural tractors and power tillers, Study of SI and CI engines used in tractors and power tillers, Study of tractor and power tiller fuel supply systems, Study of tractor electrical system, Study of tractor and power tiller transmission systems.

Study of tractor hydraulic system, Study of steering system of a tractor, Determination of center of gravity of tractor, Testing of Fuel Injection Pump and Injector of a tractor, Tractor engine exhaust testing for quality emission, Tractor noise and vibration testing, Tractor driving practice, Field

operation of tillage implements, Field evaluation of tractor drawbar performance, Evaluation tractor operator activity in field operations, Study of tractor wheel parameters.

SWLE 501 Soil & Water Conservation Engineering 3 (2-0-1)

Soil Erosion: Factors affecting and damages caused, Processes and types of erosion, Quantitative soil loss equation, Universal soil loss equation.

Soil Erosion Control Practices: Agronomical practices, Contouring, Crop rotation, Strip cropping, Vegetative control of gullies, Vegetated waterways, Mulching, Green manuring pastures and Agro-forestry.

Contour and Graded Bunds: Types and maintenance.

Bench Terraces: Types and maintenance,

Land clearing, Leveling and grading

Gully Control Structures: Types of temporary & permanent gully control structures, Land Slides & Erosion Control on Hills: Stream bank erosion, Planning, Design & construction of vegetative & machinery spur, Coastal erosion control practices, wind erosion and its control practices.

Rain Water Harvesting & Storage Structures: Water harvesting techniques, Types of water harvesting structures, Planning,.

Field visit of problematic area and study of different types of water harvesting structures.

Estimation of land shaping and grading for development, study of working of scraper, leveler and grader, operation of grader for leveling, drainage and chemical treatment of land, preparation of seed beds for rain fed farming, design, drawing and preparation of estimates for different soil conservation structures.

APFE 516 Crop Process Engineering 3 (2-0-1)

Theory : 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, 198 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 behavior 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.

SWLE 502 Irrigation Engineering 4 (3-0-1)

Source of irrigation water, measurement of irrigation water infiltration, application of soil plant atmospheric continuum and principles of fluid mechanics to design of irrigation system, water balance equation and evaluation of different components; measurement of evaporation and evapo transpiration; Estimation of irrigation water requirement and irrigation scheduling; efficiencies of irrigation systems, hydraulics, design and evaluation of surface, sub-surface, overhead and drip irrigation systems; design of water conveyance systems including control structures, design principles, characteristics curves, selection of pumps and prime movers.

Practicals: Determination of bulk density of soil, Determination of soil moisture stress at different depths by tensiometers, Aggregate analysis of soil, Determination of coefficient of permeability of soil by constant head method & variable head method, Determination of moisture content of soil by gravimetric method, Determination of infiltration characteristics of soil, Determination of coefficient of discharge of various V-notch and rectangular notches, Determination of advance and recession in check basin method of surface irrigation, Determination of uniformity coefficient of overhead and mini sprinklers, Determination of distribution uniformity of drip irrigation, Determination of head loss in irrigation pipes

SEMESTER – VII

FMP 502 Renewable Energy 3 (2-0-1)

Solar Energy option, solar radiation. Liquid flat plate collectors and their performance, concentrating collectors. Solar energy operated systems for heating, cooling, drying and water pumping, solar pond. Thermal energy storage, photovoltaic conversion.

Available wind power. Analysis of wind regimes. Types of wind mills and their characteristics. Wind pumps, coupling of pump and wind rotor. Anaerobic fermentation of biomass. Design of biogas system for heating, lighting and running IC engines. Alcohol fuels, use of alcohol fuels in IC engines. Producer gas system. Use of CNG in IC engines. Geothermal energy. Types of Non-Conventional Energy & its utilization.

Practical: Study of flat plate and concentrating type of collectors. Study of solar cooker, solar water heaters, solar dryer. Study of photo voltaic cell, solar pump. Study of different solar radiation measuring instruments. Study of windmill and wind pump.

FMP 601 Farm Machinery Design and Testing 4 (3-0-1)

Research and development aspect of farm machinery. Introduction to design parameters of agricultural machines and design procedure. Characteristics of farm machinery design. Design and selection of standard power transmission components i.e. flat belt, V belt, chains, hook's joint used in agricultural machines. Application of design principles for tillage, seeding, transplanting, weeding, plant protection, harvesting and threshing operations. CAD for selected farm machines. Reliability. Safety aspect in design. Types of testing, BIS and RNAM Test codes and procedures. Performance evaluation of selected farm machines and interpretation. Test equipments-usage and limitations. Design of selected components of farm machines.

Practical: Study of different power transmission system. Field testing & adjustments of primary & secondary tillage implements. Field-testing of power operated seed drills. Field testing of different harvesting & threshing machinery. Computer aided design of selected agricultural tools and machineries.

SWLE 505 Drainage Engineering 3 (2-0-1)

Agricultural land drainage problems, drainage requirements of crops, drainage investigation for planning and execution of drainage systems; determination of drainage co-efficient and drainable porosity; drainage methods; principles, design, analysis and layout of surface drainage, horizontal, subsurface & vertical drainage system; equipment and machines for installing drainage systems; equipment and machines for installing drainage systems, reclamation of water logged and salt affected

lands; water quality and pollution; planning of integrated irrigation and drainage system; drainage materials, their specification and comparative performance

Practical: Installation of observation wells and piezometers, Preparation of isobaths and water table contour maps, installation of surface and subsurface drainage systems, field visits to drainage projects, economic evaluation of drainage system installation,

APFE 512 Dairy and Food Engineering 4 (3-0-1)

MILK- Physical and chemical properties, selection of materials for milk handling, classification. Proceedings milk- Cream separation, pasteurization, homogenization, sterilization butter churning, cheese manufacturing, condensed and dried milk. Ghee ice cream yogurt, whey, margarine, khova, butter

Filling and Packing: - Bottle fillies, can washes packing of milk products. Maintenance of dairy plant. Dairy Equipment & plant design

General characteristics of food materials. Unit operation of various food processing system- cleaning, screening and type of screens separators. Milling- screen analysis, fineness modules, crushing efficiency- Bond's law, Kick's law, Rettinger's coefficient, oil expression and extraction, parboiling, materials handling – belt conveyors, belt Tension, bucket elevator- buckets, drive mechanism, screw conveyor, pneumatic, conveyer, Blanching, food dehydration, Drying time calculation, freezing, freezing time, types of freezing, Extrusion cooking, material and energy Balance in food Engg operation. Water activity- free bound water.

Practical: Study of vapor compression refrigerator cycle, Study of evaporative condenser, cooling tower, Study of different tanks in a dairy plant (weight tank, Storage tank, balance tank), Study of HTST pasteurizer, performance evaluation of cream separator, Performance evaluation of Butter churn, Performance of Homogenizer, Sieve analysis of Milking Products.

AET 601 Entrepreneurship Development in Agro - Industries 3 (3-0-0)

Entrepreneurship Development: Assessing overall business environment in the Indian economy. Overview of Indian social, political and economic systems and their implications for decision making by individual entrepreneurs. Globalisation and the emerging business / entrepreneurial environment. Concept of entrepreneurship; entrepreneurial and managerial characteristics; managing an enterprise; motivation and entrepreneurship development; importance of planning, monitoring, evaluation and follow up; managing competition; entrepreneurship development programs; SWOT analysis, Generation, incubation and commercialization of ideas and innovations. Government schemes and incentives for promotion of entrepreneurship. Government policy on Small and Medium Enterprises (SMEs) / SSIs. Export and Import Policies relevant to horticulture sector. Venture capital. Contract farming and joint ventures, public-private partnerships. Characteristics of Indian farm machinery industry. Social Responsibility of Business.

SWLE 503 Hydraulics & Design of Irrigation Systems 3 (3-0-0)

Hydraulics of border, check basin and furrow irrigation methods, Hydraulics of main, sub main and laterals for sprinkler and drip irrigation systems, design, operation and maintenance of surface, sprinkler and drying irrigation systems.

SWLE 504 Soil and Water Conservation Structures 2 (2-0-0)

Soil Erosion Control Practices

Contour and Graded Bunds: Types, Layout, Design, construction and Cost estimation

Bench Terraces: Types, Layout, Design, construction and Cost estimation

Temporary Gully Control Structures: Planning and design of soil bed earthen bunds, wooden post and woven wire check dam, Loose rock fill dam,

Permanent Gully Control Structures: Drop spillway, Chute and drop inlet spillway.

Rain Water Harvesting & Storage Structures: types of water harvesting and storage structures. Design, construction & maintenance of ponds and reservoir, Economic evaluation of water harvesting and storage structures

AET 500	Training – II	1 (0-0-1)
AET 580	Seminar - I	1 (0-0-1)
AET 699 a	Project (Project Formulation)	3 (0-0-3)
AET 600	Educational Tour / Field Visit	NC

SEMESTER – VIII

SWLE 601	Integrated Watershed Management	3 (2-0-1)
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Concept of watershed development and management; Watershed characteristics, problems of land degradation, land use capability classification and topographical characteristics of watershed. Integrated multi-disciplinary approach; Basic data collection on watersheds, soil and soil moisture conservation, conservation measures; Dry land farming, techniques based on watershed characteristics, sustainable Agriculture for watershed development; Biomass- management, Micro-catchments farming, Irrigation with saline water, Hi-tech irrigation methods, Reducing water losses, Forestry, Rain water management, Hydrological monitoring and modelling of watershed, Management of watershed plains; Case studies.

Practical: Field visit to watersheds of nearby areas

SWLE 604	Economic Evaluation of Water Resource Projects	3 (3-0-0)
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Data requirements and survey, Topographical, geological, hydrological, socio-economic technological; Market survey; Identification of alternate options and associated data requirements and survey, Project feasibility; Demand assessment; Planning period and time horizon, economic –demographic projections, integrated and desegregated analysis and model building; Demand resilience and consumer behavior, Basic economic concept: present worth, future worth, annuities, discounting techniques, depreciation, Production function and cost curves: Components of cost curves, learning curve, expansion path, long term and short term, Estimation of project benefits and costs, Tangible and intangible values, indifference curves, Pricing concepts; oligopolies kinked demand curve model, skimming price and penetration price, Economic of natural resources management, Field and finance, Financial analysis, Economic and financial models, Analysis of water resources projects in real- world settings, Benefit cost analysis, Risk considerations, Project optimality, Mathematical models for multipurpose and multi-objective projects, Technological economics, Capital budgeting and cost allocation.

SWLE 605 Water Laws & Policies***3 (3-0-0)**

Canal acts, land laws, Ground water legal issues, Disposal and pollution control laws, Surface and subsurface water laws legal procedures, water disputes, Water boards and authorities.

SWLE 606 Minor Irrigation**3 (2-0-1)**

Definitions, scope and progress of minor irrigation works in UP, Geologic formation for ground water supply; Methods for ground water exploration, Litho logical investigations and aquifer studies, Design and construction of water storage reservoirs; Equilibrium and non-equilibrium flow to wells, Open and tube wells, Development of wells.

Practical: field visits and study of minor irrigation projects

SWLE 607 GIS and Remote Sensing**3 (2-0-1)**

Principles and concepts, Introduction to the physics of remote sensing, Spectral characteristics of land, Mission planning, Sensors for Environmental monitoring, Visible wave lengths, Camera, Vidicon, Multi spectral scanner, Infrared, Radiometer, Thermal scanner, Microwave bands, Imaging radar, Spectrometer, Sensor platforms for data collection, Ground observations, Radiometric and conventional data, Airborne system, Side looking radar, MSS satellite systems, Landsat, HCM, Meteosat SPOT, Data analysis and inter- presentation, Remote sensing data products, Multispectral and diachronic approaches, Image analysis, Pattern recognition and classification techniques, Interpretation outputs, Remote sensing for land surveys, Land escape inventories, Soil and land use mapping, Crop and vegetation studies, Remote sensing for water resources, Remote monitoring of hydrological parameters, Rainfall and evaporation estimates, Soil moisture, Remote sensing of ground water, river and lake systems, Contamination studies.

Practical: Analysis and interpretation of remote sensing data , Study of satellite imagery, border information and marking reference system , Interpretation of cultural details from IRS and SPOT imagery, Preparation of LANDSAT Map using satellite imager FCC

SWLE 610 Landscape Irrigation Design & Management**3 (3-0-0)**

Irrigation equipments & materials. Types of sprinklers, microproducts, quick coupler equipments. System operation, system freeze protection, Piping. Hydraulics, pressure. Piping system design. Fluctuation in city water pressure. Determining capacity of existing piping system. Water hammer, cross connection control, pumps. Pump operation with irrigation controller, Hydropneumatic pressure system. Booster pumps. Design of landscape irrigation equipments. Head layout, microirrigation. Golf course system. Valve wiring, controller wiring, grounding controller system, pump circuit, Lighting suppression & fountains.

SWLE 602 Water Harvesting & ground Water Recharge**3 (3-0-0)**

Water harvesting; Scope, need & types of water harvesting, long term & short term water harvesting techniques, water harvesting structures, design of water harvesting structure & ponds, water harvesting techniques for hilly and arid region.

Reservoir type storage structures; Definition and types, storage or conservation reservoirs, flood control reservoir, multipurpose reservoir & distribution reservoirs planing & site selection, water yields for catchments, estimation of runoff, reservoir components, capacity –elevation curves of reservoir, storage zones of reservoirs, design of reservoirs capacity, Bibliographical and analytical method; Stenz's table Barlow table, Lacy's formula, Inglis formula, Khosla formula, determining reservoir capacity for a given demand & vice versa, Demand pattern of various reservoirs, Hydrologic reservoir routing method, Sedimentation, Reservoir losses spillway design.

SWLE 512 Wasteland Management**3 (3-0-0)**

Land suitability classification according to USBR; Land suitability categorizes according to FAO framework; Land evaluation; Mapping of degraded soil through soil survey; Land degradation in arid semiarid regions; Land degradation due to erosion, Land degradation management by soil conservation practices, Causes, Reclamation and management of water logged and salt affected soils, Rehabilitation and management of ravine lands, Selection, Design, and management of Irrigation and drainage system in watersheds, Economic evaluation of watershed development projects.

**SWLE 603 Operation, Maintenance & Economic Evaluation of
Water Resource Projects 3 (3-0-0)**

Physics surface irrigation; Design and evaluation procedure for border, Check basin and furrow irrigation; Guidelines for operational and maintenance and surface irrigation methods. Description of quick coupling, Dragline and moveable sprinkler irrigation systems and center Pivot system; Design, installation operation and maintenance of sprinkler irrigation systems; spray losses and drop size distribution in sprinkler irrigation systems and efficiency evaluation. Suitability of drip irrigation system under Indian conditions; Types of drip irrigation systems; Emitter types; Emitters construction; Discharge of principles for emitters; design of drip irrigation systems; Data requirements and survey, Topographical, geological, hydrological, socio-economic technological; Market survey; Identification of alternate options and associated data requirements and survey, Project feasibility; Demand assessment; Planing period and time horizon, economic –demographic projections, integrated and desegregated analysis and model building; Demand resilience and consumer behavior, Basic economic concept: present worth, future worth, annuities, discounting techniques, depreciation, Production function and cost curves: Components of cost curves, learning curve, expansion path, long term and short term, Estimation of project benefits and costs, Tangible and intangible values, indifference curves, Pricing concepts; oligopolies kinked demand curve model, skimming price and penetration price, Economic of natural resources management, Field and finance, Financial analysis, Economic and financial models, Analysis of water resources projects in real- world settings, Benefit cost analysis, Risk considerations, Project optimality, Mathematical models for multipurpose and multi-objective projects, Technological economics, Capital budgeting and cost allocation.

SWLE 611 Water Quality Management**3(2-0-1)**

The Physical chemical, Biological and hydrological characteristics of surface water system in junction to water quality management; characterization of water quality in natural system; Contamination of water quality due to human activity; Engineering Management practices and methodologies, with particular emphases on total maximum daily load and waste load location approaches for minimizing contaminant inputs; water quality problems domains in stream and river system, lakes reservoirs and ground water system; Ecological principles impacting water quality; Hydrologic and hydraulic principles relating to water quality monitoring; Assessment, remediation, planning and management, and post audit/monitoring strategies; Various pollution constituents point and nonpoint diffused surface subsurface interaction; State and Federal water quality legislation and permits; standards and criteria; Treatment methods: aeration, nutrient inactivation, biological manipulation, etc.

Practical: Determination of all Physio Chemical properties of water; pH; temperature; Conductive; Dissolved Oxygen; Nitrate; Nitrite; Fecal; Coliform; Turbidity Hardness; BOD.

SWLE 612 Reservoir and Farm Pond Design**3 (2-0-1)**

Theory: 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.

SWLE 408 Environmental Engineering**3 (3-0-0)**

Environment and its component, Pollution of environment by human activity, introduction to water, air, land, thermal & noise pollution, introduction to environmental impact pollution, ecology and ecosystem, concept of ecology imbalances, elements of environmental analysis, introduction of water quality impact analysis, environmental legislation and environmental audit; Industrial process and waste treatment unit, sedimentation, design of primary and secondary sedimentation tank. Settling and removal efficiency for discrete and flocculent setting mechanics of coagulation, flocculation. Filtration; Suitability of sewage for irrigation, location and design of sewage farms, public health aspects of sewage farms, economic and social aspects of sewage irrigation. Disposal of sewage on land, techniques for environmentally sound water resource development.

APFE 611 Food Packaging Technology**3 (2-0-1)**

Basic concepts of food packaging. Packaging operations, package functions and package design consideration. Principles in the development of protective packaging. Packaging materials and their properties. Different types of food packages. Special packaging methods such as vacuum gas and shrink packaging. Special problems in packaging of different foodstuffs. Test procedure for packaging material and packaged foods. Principles of packaging equipments, package standards and regulations. Marketing and economics.

Strength properties of packaging materials. Water vapour and gas transmission rates of flexible packaging materials. Identification of plastic films. Chemical resistance of plastics films. Package products compatibility tests. Estimation of shelf –life of packaged food stuffs. Vacuum and gas packaging. Performance evaluation of transport packages.

Practical: Identification of different packaging materials, study of vacuum packing machine, study of shrink packing machine, study of form-fill-seal packing machine, Tests & signification of corrugated fiber boxes, transport worthiness tests, study of food label & collections of various types label, calculation of shelf life of food, visit to a can manufacturing unit, visit to a glass manufacturing unit.

APFE 602 Food Process Equipment Design**3 (2-1-0)**

Application of design engineering for food processing equipments, Design parameters, codes and materials selection. Design handling and milling equipments, dryers, heat exchangers, Pressure vessels, Optimization of design with respect of process efficiency, Design of fluid conveyance system, Design of evaporator, vapor separator and condenser. Equipments lay out and ventilation in food processing plants, computer assisted design of a heat exchanger, dryers and a storage system.

APFE 614 Food Laws & Legislation**2(2-0-0)**

Concept and significance of Food Legislation, Indian Food Laws and Legislation, Prevention of Food Adulteration (PFA), Beauru of Indian Standards (BIS), Agmark, Agricultural and Processed Food Products Export Development Authority (APEDA), International Standardization and Organization (ISO), Codex Alimentarius Commission (CAC), Food Laws and legislation in EU, Middle East, SAARC and ASEAN.

APFE 615 Entrepreneurship in Food Industries**2(2-0-0)**

Identification of Business opportunities, market survey, project formulation, selection of product, choice of technology, financial institutions, fund flow analysis, functional ratio, techno-economic feasibility of project, costing and pricing, industrial sickness and remedies.

APFE 508 Food Plant Sanitation & Waste Management**3(2-0-1)**

Sanitary design of food process equipment, Selection of sanitizing agents for cleaning, packaging sanitation, food storage sanitation, transport sanitation and water sanitation. By-products obtained from dairy plant, egg & poultry processing industry and meat industry. Characterization of food industry wastes e.g., BOD, COD and total organic content, floatable and suspended solids in water, pretreatment, secondary treatments of solid waste, sludge volume index, advanced techniques activated bio-filtration, biological fluidized bed reactor, dried bacteria culture process tertiary treatments or advanced waste water treatment system (AWT); polishing ponds, DAF Techniques, micro trainers treatment and disposal of sludge, sand filters, removal of nitrogen, phosphorus, sulphur, physical chemical treatment process.

Practical: Flow process chart of food plant Waste utilization processes, various treatment for waste disposal analysis of cleaners & sanitizers, CIP Cleaning.

APFE 601

Food Plant Design & Maintenance

3(2-1-0)

Food Plant Design and Maintenance plant Design consideration, feasibility Analysis, financial analysis, plant location, plant layout, process selection, process flow Analysis, choice of Technology, Scheduling, Job Design Performance measurement and improvement, Replacement and maintenance. Physical properties of food materials and energy balance calculations for preliminary estimation of plant capacity & equipment sizes. Preparation of flow sheets for material movement and utility consumption in food plant. Design of storage vessels, pressure vessels & vessels for drum drying. Design of fluid conveyance system, heat exchangers, evaporators, condenser, vapor separator etc. Performance characteristics and selection of fan, blowers ejector compressors & vacuum pumps. Design considerations for food plant, equipment lay-out and ventilation in food process plant. Performance characteristics and selection of centrifugal & positive displacement sanitary pumps. Food plant maintenance including preventive & break down maintenance.

APFE 509

Fermented Food Products

3(2-0-1)

Food fermentation, stock culture and inoculum preparation. Lactic acid fermentation of milk, vegetables, cereals and meat. Alcoholic fermentation of fruit juices, sugar and starch substrates. Vinegar fermentation, mixed fermentation of cereal legumes and milk. Malting, brewing, steeping, germination, kilning and curing. Chemical and biochemical changes during malting and mashing. Separation of wort, wort boiling and hops addition. Fermentation, separation, maturation, carbonation and packaging.

Practical: Lactic acid fermentation. Alcoholic fermentation of fruit juices. Acetic acid fermentation and alkaline fermentation. Barley steeping. Germination, malting mashing and brewing; Preparation of wine and distillation of wine.