Course Structure & Detailed Syllabus for B. Tech in Agricultural Engineering and Technology, School of Engineering and Technology, Nagaland University, Dimapur

(Revised course structure for the Department of Agricultural Engineering and Technology w. e. f. Academic Session 2024 onwards)

SECOND YEAR

3rd Semester

Theory							
SL. No	**Subject Code**	**Course Name**	**Contact hours per week**				**Credits**
			L	**T**	**P**	**Total**	
1	BSH302	Mathematics - III	2	1	-	3	3
2	AE3T01	Strength of Material	3	-	-	3	3
3	AE3T02	Soil Mechanics	3	-	-	3	3
4	AE3T03	Farm Power	3	-	-	3	3
5	**AE3T04**	**Electrical Machine & Power utilization**	**2**	**-**	**-**	**2**	2
6	AE3T05	Engineering properties of Biological Material & Food Quality	2	-	-	2	2
7	**AE3T06**	**Machine drawings & Computer graphics**	2	-	-	2	2
					Total Theory	***18***	***18***
Practical							
1	AE3L01	Soil Mechanics Lab	-	-	2	2	1
2	AE3L02	Farm Power Lab	-	-	2	2	1
3	AE3L03	Engineering properties of Biological Material & Food Quality Lab	-	-	2	2	1
4	**AE3L04**	**Machine drawing & Computer graphics lab**	-	-	2	2	1
					Total Practical	***8***	***4***
					Total of Semester	***26***	***22***

4th Semester

Theory							
SL/No	**Subject Code**	**Course Name**	**Contact hours per week**				**Credits**
			L	**T**	**P**	**Total**	
1	AE4T01	Surveying and Leveling	2	-	-	2	2
2	AE4T02	Theory of Machines	2	1	-	3	3
3	AE4T03	Design of Structures	2	-	-	2	2
4	AE4T04	Watershed hydrology	2	1	-	3	3
5	AE4T05	Fluid Mechanics	2	1	-	3	3
6	AE4T06	Crop Process Engineering	3	-	-	3	3

7	AE4T07	Engineering Thermodynamics and Heat Engine	2	-	-	2	2
					Total Theory	***18***	***18***
Practical							
1	AE4L01	Watershed Hydrology Lab	-	-	2	2	1
2	AE4L02	Crop Process Engineering Lab	-	-	2	2	1
3	AE4L03	Surveying and Leveling Lab	-	-	2	2	1
					Total Practical	***6***	***3***
					Total of Semester	***24***	***21***

THIRD YEAR

5th Semester

Theory							
SL/ No	**Subject Code**	**Course Name**	**Contact hours per week**				**Credits**
			L	**T**	**P**	**Total**	
1	AE5T01	Workshop Technology	2	-	-	2	2
2	AE5T02	Machine Design	2	-	-	2	2
3	AE5T03	Heat & Mass Transfer	2	-	-	2	2
4	AE5T04	Farm Machinery & Equipment	3	-	-	3	3
5	AE5T05	Ground Water, Wells & Pumps	2	-	-	2	2
6	AE5T06	Drying & Storage Engineering	3	-	-	3	3
7	AE5T07	Soil & Water Conservation Eng.	3	-	-	3	3
					Total Theory	***17***	***17***
Practical							
1	AE5L01	Farm Machinery & Equipment Lab	-	-	2	2	1
2	AE5L02	Ground Water, Wells & Pumps Lab	-	-	2	2	1
3	AE5L03	Drying & Storage engineering Lab	-	-	2	2	1
4	AE5L04	Soil & Water Conservation Eng. Lab	-	-	2	2	1
					Total Practical	***8***	***4***
					Total of Semester	***25***	***21***

6th Semester

Theory							
SL/ No	**Subject Code**	**Course Name**	**Contact hours per week**				**Credits**
			L	**T**	**P**	**Total**	
1	AE6T01	Agriculture for Engineers	3	-	-	3	3
2	AE6T02	Refrigeration & Air conditioning	2	1	-	3	3
3	AE6T03	Transfer Process in Food Engineering	3	-	-	3	3
4	AE6T04	Tractor systems & controls	2	-	-	2	2
5	AE6T06	Irrigation and Drainage Engineering -I	2	-	-	2	2
6	AE6EL	Elective-I	3	-	-	3	3

			Total Theory			***16***	***16***
Practical							
1	AE6L01	Tractors Systems & Controls Lab	-	-	2	2	1
2	AE6L02	Irrigation and Drainage Engineering I Lab	-	-	2	2	1
			Total Practical			***4***	***2***
			Total of Semester			***20***	***18***

Elective papers-I:

1. (AE6EL01) Agribusiness Management and Trade
2. (AE6EL02) Entrepreneurship Development and Communication Skills
3. (AE6EL03) Design and Maintenance of Greenhouse
4. (AE6EL04) Soil & Water Conservation Structure
5. (AE6EL05) Environmental Pollution

FOURTH YEAR

7th Semester

Theory							
SL/ No	**Subject Code**	**Course Name**	**Contact hours per week**				**Credits**
			L	**T**	**P**	**Total**	
1	AE7T01	Irrigation and Drainage Engineering -II	2	-	-	2	2
2	AE7T02	Mechanics of Tillage & Traction	2	-	-	2	2
3	AE7T03	Unit Operation in Dairy and Food Engineering	2	-	-	2	2
4	AE7T04	Statistical Hydrology	2	-	-	2	2
5	AE7T05	Industrial Training	-	-	-	2	2
6	AE7T06	**Project - I**	-	-	8	8	4
7	AE7EL	Elective-II	3	-	-	3	3
					Total Theory	***21***	***17***
Practical							
1	AE7L01	Mechanics of Tillage & Traction Lab	-	-	2	2	1
2	AE7L02	Unit Operation in Dairy and Food Eng. Lab	-	-	2	2	1
					Total Practical	***4***	***2***
					Total of Semester	***25***	***19***

Elective papers-II:

1. (AE7EL01) Remote Sensing & GIS Application
2. (AE7EL02) Tea Technology
3. (AE7EL03) Development of Processed Products & Equipment
4. (AE7EL04) Waste and By-product Utilization
5. (AE7EL05) Food Processing Plant Design & Layout
6. (AE7EL06) Contaminant Hydrology

8th Semester

Theory							
SL/ No	**Subject Code**	**Course Name**	**Contact hours per week**				**Credits**
			L	**T**	**P**	**Total**	
1	AE8T01	Tractor Design & Testing	2	-	-	2	2
2	AE8T02	Food Process and Packaging Technology	3	-	-	3	3
3	AE8T03	Watershed Planning & Management	2	-	-	2	2
4	AE8T04	Project - II	-	-	8	8	4
5	AE8EL	Elective – III	3	-	-	3	3
6	BSH801	Indian Constitution	3	-	-	3	NC
					Total Theory	***21***	***14***
Practical							
1	AE8L01	Tractor Design & Testing Lab	-	-	2	2	1

2	AE8L02	Food Process & Packaging Technology Lab	-	-	2	2	1
3	AE8L03	Seminar	-	-	2	2	1
					Total Practical	***6***	**3**
					Total of Semester	***27***	**17**

Elective papers-III:

1. (AE8EL01) Human Engineering & Safety.
2. (AE8EL02) Biomass Management for Fodder and Energy.
3. (AE8EL03) Production Technology of Agricultural Machines.
4. (AE8EL04) Renewable Energy Source
5. (AE8EL05) Organic Farming for Sustainable Agricultural Production (will be offered through MOOCs/SWAYAM/NPTEL plate form)

SUMMARY OF CONTACT PERIODS PER WEEK AND CREDITS

Semester	Contact periods/ week	Credits
I	**25**	**21**
II	**29**	**21**
III	**26**	**22**
IV	**24**	**21**
V	**25**	**21**
VI	**20**	**18**
VII	**25**	**19**
VIII	**27**	**17**
TOTAL	**201**	**160**

DETAILED SYLLABUS

The detailed syllabus for the four-year B. Tech program in Agricultural Engineering & Technology:

THIRD SEMESTER

MAT3T1 – Mathematics – III **(2 – 1 – 0 – 3)**	
Unit - I	Fourier Series and Fourier Transforms: Euler's formulae, conditions for a Fourier expansion, change of interval, Fourier expansion of odd and even functions, Fourier expansion of square wave, rectangular wave, saw-toothed wave, half and full rectified wave, half range sine and cosine series, complex form of Fourier series.
Unit - II	Fourier integral theorem – Fourier transform pair-Sine and Cosine transforms – Properties – Transform of elementary functions – Convolution theorem – Parseval's identity.
Unit - III	Partial differential Equations, Formation, solutions of first order equation, singular solutions, Lagrange's Linear equation, Integral surfaces passing through a given curve, solutions of linear equations of second order and their classifications-parabolic, elliptic and hyperbolic
Unit - IV	Applications of Partial Differential Equations, Method of separation of Variables, Solutions of one dimensional wave equation and one dimensional heat equation, Steady state solution of two-dimensional heat equation
Unit - V	Z-transform – Elementary properties – Inverse Z-transform – Convolution theorem – Initial and Final value theorems – Formation of difference equation – Solution of difference equation using Z-transform
	Books: 1. Higher Engineering Mathematics: B. S. Grewal 2. Advanced Engineering Mathematics: E. Kreyszig 3. Advanced Engineering Mathematics: Jain and Iyenger 4. Advanced Engg. Mathematics: Michael D. Greenberg 5. Advanced Engineering Mathematics (7th Edition): Bali N., Goyal M.

AE3T01 – Strength of Materials **(3 – 0 – 0 – 3)**	
Unit - I	Introduction: Simple stresses and strains: Normal and shearing stresses in axially loaded members; Concept of factor of safety; Normal and shearing strains; stress strain relationship; Hooke's law; Modulus of rigidity; complementary shear stress; Poisson's ratio; Bulk modulus; Relation between various elastic constants; Volumetric strain.
Unit - II	Mechanical properties of materials: Definition of elastic materials; plastic materials; Ductile materials; Brittle materials; Permanent set; Elastic limit, Fatigue limit; Ultimate strength; Modulus of resilience; Modulus of toughness; Modulus of rupture; Proof stress; Malleability; Toughness and hardness and their measurement.
Unit - III	Mechanics of rigid bodies: Types of supports. Centroid and moment of inertia: Centroid and center of gravity; Second moment of inertia; polar moment of inertia; Radius of gyration. Bending moment and shear force: Definition and concept; SFD and BMD for cantilever; Simply supported and overhanging beams subjected to various combinations of loadings; Point of inflection; Elastic curves; Relation between the load S.F. and B.M.

	Bending stress, flexure formula, shear stress distribution, deflection and slope, torsion of shafts, Principal stresses and strains.
	Books: 1. Gera, J.M and. Timoshenko, S.P, Mechanics of Materials,, CBS Publishers & Distributors, 2nd Edition, New Delhi, 1980. 2. Punmia, B.C, Strength of Materials & Mechanics of Structures, Vol.I&II,, Standard publishers & Distributors, 1988. 3. Junnarkar, S.B, Mechanics of Structures, Vol.I&II, 15th edition,, Charotar publishing 4. house, Anand, 2000 Singer, F.L, & Pytel, A., Strength of materials, Harper & Row Publisher, New York, 1980.F.L. Singer & A. Pytel

AE3T02 – Soil Mechanics **(3 – 0 – 0– 3)**	
Unit - I	Introduction of soil mechanics, field of soil mechanics, phase diagram physical and index properties of soil classification of soils, general classification based on particle size, textural classification and I.S. soil classification system stress condition in soils, effective and neutral stress, elementary concept of Boussinesq and Wester guards analysis, new mark influence chart.
Unit - II	Shear strength Mohr stress circle, theoretical relationship between principle stress circle, theoretical relationship between principal stress Mohr-coulomb failure theory, effective stress principle. Determination of shear parameters by direct shear to be a circle, theoretical test. Numerical exercise based on various types of tests. Compaction composition of soils standard and modified proctor test, abbot compaction and Jodhpur mini compaction text field compaction method and control.
Unit - III	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.
	Books: 1. Punmia, B.C., Jain, Ashok.K., & Jain, Arun K. Soil mechanics & foundations, 13th edition, Laxmi pub. Pvt.Ltd., New Delhi, 1994. 2. Lambe, T.W. & Whitman,R.V., Soil mechanics SI version, Wiley eastern Ltd., 1979. 3. Murthy, V.N.S., UBSPD, Principles of Soil mechanics & foundation engineering, New 4. Delhi, 2001. Singh, A., and howdhury, G.R.C., Soil engineering in theory and practice, part - 1 & 2, CBS Publishers and Distributors, New Delhi, 1994.

AE3L01 – Soil Mechanics Lab	
1.	Determination of water content of soil.
2.	Determination of specific gravity of soil.
3.	Determination of field density of soil by core cutter method.
4.	Grain size analysis by sieving (Dry sieve analysis).
5.	Determination of liquid method by Casagrande's method.
6.	Determination of liquid limit by cone penetrometer and Plastic limit.
7.	Determination of permeability by constant and variable head method.
8.	Determination of compaction properties by standard proctor test.
9.	Determination of shear parameters by Direct shear test.
10.	Determination of shear parameters by Triaxial test.

AE3T03 – Farm Power (3 – 0 – 0 – 3)	
Unit - I	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.
Unit - II	Study of engine components, their construction, operating principles and functions. Engine system: valves & valve mechanism. Fuel & air supply, cooling, lubricating, ignition, starting and electrical systems. Study of constructional details, adjustments & operating principles of these systems.
Unit - III	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, antifreeze and anti-corrosion materials, lubricant types & study of their properties. Engine governing systems.
	Books:
1.	Farm power, B.D.Mosses & K.R.Frost, 1952 edition, John Wiley & sons Pvt.Ltd, ew
2.	York, 1952.
	Tractor & power units, John B. Liljedahly, W.M. Carleton, P.K. Turnquist &
3.	Makotohoki, 4th edition CBS pub. & Dist., New Delhi, 1977.
	Off-road vehicle engineering principles, Goering, Caroll E, marvin L.Stone, Dvid W.
4.	Smith & Paul K.Turnquist, 2003 edition, ASAE, St.Joseph, Michigan.
	Engine and Tractor power, Goering, Caroll E and Alan C.Hansen, 2004 edition, ASAE, St.Joseph, Michigan.

AE3L02 – Farm Power Lab(1)

1.	Introduction of different systems of an IC engine.
2.	Engine parts and functions, working principle etc.
3.	Valve system- study, construction and adjustment.
4.	Oil & Fuel- determination of physical properties.
5.	Air cleaning system.
6.	Fuel supply system of SI engine.
7.	Diesel injection system and timing.
8.	Cooling system & fan performance, thermostat and radiator performance evaluation.
9.	Part load efficiencies & governing.
10.	Lubricating system & adjustment.
11.	Starting an electrical system.
12.	Tractor engine heat balance and engine performance curve.
13.	Visit to engine manufacturer/assembler/spare parts agency.

AE3T04 – Electrical Machine and Power Utilization **(2 – 0 –0 – 2)**	
Unit - I	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.
Unit - II	Principles, operation and performance of, DC machine (generator and motor). EMF and torque equations, armature reaction, commutation and characteristics of DC machines, starting methods of DC motors.
Unit - III	Induction & Synchronous machines- construction, operation, equivalent circuit, phasor diagram, torque equation, Starting methods of Induction and synchronous motors.
Unit - IV	Single phase induction motor, split phase and shaded pole motors, reluctance motor, Hysteresis motor. Double field revolving, theory, equivalent circuit, characteristics & application
	Books: 1. Electrical Machinery, P.S. Bhimra, Khanna Publications, Delhi. 2. Principles of Electrical machines, V.K. Mehta & Rohit Mehta

AE3T05 – Engineering Properties of Biological Material & Food Quality **(2 – 0 – 0 – 2)**	
Unit - I	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. 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.
Unit - II	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. Measurement of colour, flavour, consistency, viscosity, texture and their relationship with food quality and composition..
Unit - III	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.
	Books: 1. Sahay K.M. & Singh K.K., Unit operations of Agricultural Processing, Vikas publishing house, New Delhi, 2nd edition, 2001. 2. Chakraborty A., Post Harvest Technology of cereals, pulses & Oil seeds,, Oxford & IBH Pub. New delhi, 3rd edition, 2000 3. Michael A. M. & OjhaT. P. Principles of Agricultural Engineering-I, , Jain Brothers Publ. New Delhi, 2006

AE3L03 – Engineering Properties of Biological Material & Food Quality Lab (1)	
	1. To find the shape and size of grain and fruits and vegetables. 2. To determine the bulk density and angle of repose of grain. 3. To determine the practical density/true density and porosity of soil grain. 4. To find out the coefficient of external and internal friction of different crops. 5. To study the separating behavior of a grain sample in a vertical wind tunner (Aspirator column). 6. To find the thermal conductivity of different grains. 7. To determine specific heat of some food grains. 8. To determine the cooking quality of rice. 9. To determine impurities and invisible stress cracks in grains. 10. Determination of hardness of food materials. 11. Detection of adulteration in food product viz. milk, ghee, honey etc.

AE3T06 – Machine Drawings & Computer Graphics (2 – 0 –0 – 2)	
Unit - I	First and third angle methods of projection. Preparation of working drawing from models and isometric views. Drawing of missing views. Different methods of dimensioning.

Unit - II	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.
Unit - III	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.
Unit - IV	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.
Unit - V	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
	Books: 1. Engineering Drawing, N.D. Bhatt, Charotar Publishing House, 46th edition, 2003. 2. Gopalakrishnan K.R, Machine Drawing Jovast Publishers, Thrissur, 1993.

AE3L04 – Machine Drawings & Computer Graphics Lab **(1 – 0 – 0 – 1)**	
1.	Preparation of manual drawings with dimensions for models and isometric drawings of objects and machine components.
2.	Preparation of sectional drawings of simple machine parts.
3.	Drawing of riveted joints and thread fasteners.
4.	Demonstration on computer graphics and computer aided drafting use of standard
5.	software.
6.	Practice in the use of basics and drawing commands on auto cad.
7.	Generating simple 2-D drawings with dimensioning using auto cad. Practice in the use of modify and rebelling commands.
8.	Practice in graphics mathematics, curve fitting and transformations. Demonstration on CNC machine.

FOURTH SEMESTER

AE4T01 – Surveying and Levelling **(2 – 0 – 0 – 2)**	
Unit - I	Surveying: Definition, principles and basic concepts of surveying, classification, basic measurements, units of measurement, plans and map, types of scales, principle of chain surveying – definition, selection of survey station and lines, types of ranging and chaining, recording the measurements, offset measurements, cross staff, optical square, prism square, obstacles in chaining and ranging chain and tape correction
Unit - II	Traversing: Method of traversing, prismatic and surveyor compass, angle and bearing, quadrantal systems, local attraction, magnetic, dip – traversing, plotting, Bowditch rule, transit rule, errors in compass survey, limits of accuracy. Plane tabling: Instrument and accessories, methods, and principles, two point, three point problems, errors in plane tabling, minor instrument – hand level, abbey level, clinometers, sextant, planimeter, pentameter, computation of areas – methods
Unit - III	Levelling: Definition, benchmarks types of levels, optical principles, lenses, telescope, sensitivity of bubble tubes, leveling staves, basic principles of leveling, temporary adjustments, field book entries, reduction of levels, missing entries, type of leveling, simple, differential and profile leveling, cross sectioning.
	Books: 1. Davis, R. E. ,Elementary Plane Surveying. McGraw Hill. 2. Higgins, A. L., Elementary Plane Surveying. McGraw Hill. 3. Kanetkar, T.P. , & Kulkarni, S.V., Surveying and Levelling (part I & II). Griha Prakashan.

AE4L03 – Surveying and Leveling Lab(1)	
1.	Handling of chain and chain accessories, offsetting with field work
2.	Ranging out survey line and plotting chain survey
3.	Triangulation of chain and offsetting for details for preparation of map of small area.
4.	Plotting of field book, reading for preparation of map – acquaintance with symbols of different objects used in map and scale of map.
5.	Setting up of Prismatic compass and measurement of angles.
6.	Traversing of small area with chains and prismatic compass and offsetting for details.
7.	Plotting of the map with chain and prismatic survey
8.	Setting up plane table and offsetting by inter – section method
9.	Plane table traversing
10.	Setting up dumpy levels and exercise in fly leveling and reciprocal leveling.

AE4T02 – Theory of Machines **(2 – 1 – 0 – 3)**

Unit - I	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.
Unit - II	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.
Unit - III	Turning moment diagrams, coefficient of fluctuation of speed and energy, weight of flywheel, flywheel applications. Belt drives, types of drives, belt materials. Length of belt, power transmitted, velocity ratio, belt size for flat and V belts. Effect of centrifugal tension, creep and slip on power transmission, Chain drives.
Unit - IV	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 of analysis of Watt, Porter, Proell governors. Effect of friction, controlling force curves. Sensitiveness, stability, hunting, isochronisms, 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
	Books: 1. Khurmi, R.S ,Theory of Machines, 2. Norton, R.L.,Theory of Machines & Mechanism –McGraw Hill. 3. Rattan, Theory of Machines - , Tata McGraw Hill, New Delhi. 4. Abdulla and Sharif,Theory of Machines – Khanna Publishers.

AE4T03 – Design of Structures **(2 – 0– 0 – 2)**	
Unit - I	Loads and use of BIS Codes. Design of connections. Design of structural steel members in tension, compression and bending. Design of steel roof truss.
Unit - II	Analysis and design of singly and doubly reinforced sections, Shear, Bond and Torsion.
Unit - III	Design of Flanged Beams, Slabs, Columns, Foundations, Retaining walls and Silos.
	Books: 1. Vaidyanadhan, R and Perumal, P, Comprehensive Structural Analysis – Vol. I & Vol. II, Laxmi Publications, New Delhi, 2004. 2. Punmia B.C, Ashok Kumar Jain and Arunn Kumar Jain, Theory of Structures – II, Laxmi Publication Pvt. Ltd. 2004.

AE4T04 – Watershed Hydrology **(3 – 0 –0 – 3)**	
Unit - I	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; evapotranspiration - estimation and measurement

Unit - II	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.
Unit - III	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.
	Books: 1. Singh, V.P., Elementary Hydrology, 1st edition, Prentice Hall of India, New Delhi, 1994. 2. Raghunath, H.M., Hydrology : Principles, Analysis and Design, 3rd edition., New Age International, New Delhi, 2001. 3. Dhruvnarayanan, V.V., Watershed Management, ICAR, New Delhi, 1990. 4. Suresh, R., Soil and Water Conservation Engineering, 2nd edition, Standard Publisher and Distributors, New Delhi., 1997.

AE4L01 – Watershed Hydrology - I Lab **(1)**	
1.	Visit to meteorological observatory.
2.	Study of different types of rain gauge.
3.	Double mass curve technique.
4.	Determination of average depth of rainfall and frequency analysis.
5.	Study of stage recorders and current meter.
6.	Study of Class-A Pan evaporimeter.
7.	Determination of infiltration rate using double ring infiltrometer.
8.	Exercises on hydrograph and unit hydrograph.
9.	Exercise on design and location of retards for channel improvement.
10.	Exercise on flood routing problem.

AE4T05 – Fluid Mechanics **(2 – 1 –0 – 3)**	
Unit - I	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 submerged and floating bodies.
Unit - II	Kinematics of fluid flow: Lagrangian and aulerian description of fluid motion, continuity equation, path lines, streak lines and stream lines, stream function, velocity potential and flownet. 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 plate 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
Unit - III	Moody's diagram, Minor and major hydraulic losses through pipesand fittings, flow through network of pipes, hydraulic gradient and energy gradient, power transmission through pipe. Dimensional analysis and Rayleigh's method and Buckingham's 'Pi' theorem, types of similarities, dimensional analysis, dimensionless numbers. Introduction to fluid.
	Books: 1. Streeter, V.L., Wylie, E.B., Fluid Mechanics, McGraw Hill Book Co. Singapore, 1983. 2. Modi, P.N., Seth, S.M., Hydraulics & fluid Mechanics of Structures, Standard Book House, Nai Sarak, Delhi, 1999. 3. Bansal, R.K., Fluid Mechanics & Hydraulic Machines, Laxmi Publication Pvt.ltd., New 4. Delhi, 2000. Khurmi, R.S., A text book of hydraulics, fluid mechanics & hydraulic machines, S.Chand & company, New Delhi, 2000.

AE4T06 – Crop Process Engineering **(3 – 0 –0 – 3)**	
Unit - I	Scope and importance of food processing, principles and methods of food processing. Theory of separation, size and un sized separation, types of Separators,size of screens, sieve analysis, capacity and effectiveness of screens, pneumatic separation. Principle of size reduction, grain shape, size reduction machines; crushers, grinders, cutting machines etc.-operations, efficiency and power requirement- Rittinger's, Kick's and Bond's equation, fineness modulus.
Unit - II	Processing of farm crops; cereals, pulses, oil seeds, fruits and vegetables and their products for food and feed. Processing of animal products. Theory of mixing, types of mixtures for dry and paste materials, rate of mixing and power requirement, mixing index. Theory of filtration, study of different types of filters, rate of filtration, pressure drop during filtration.
Unit - III	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. By-Products of Agricultural processing and their Utilization.
	Books: 1. Sahay, K.M. & Singh, K.K. Unit operations of Agricultural Processing, , Vikas publishing house, New Delhi, 2nd edition, 2001 2. Chakraborty, A. Post Harvest Technology of cereals, pulses & Oil seeds, Oxford & IBH Pub. New delhi, 3rd edition, 2000 3. Brennan, J.G., .Butters, J.R, Cowell, N.D. & .Lilly, A.E.V. Food Engineering Operations, Elsevier pub. 3rd edition, 2009 4. Fellows, P.J. Food Processing Technology Principles & Practice, , Woodhead Pub. New Delhi, 3rd edition, 2009.

AE4L02 – Crop Process Engineering Lab **(1)**	
1. 2. 3. 4. 5. 6. 7. 8. 9. 10. 11.	Preparation of flow and layout charts of a food processing plant. Determination of fitness modulus and uniformity intex. Performance evaluation of a hammer mill. Performance evaluation of attrition mill. Study of equipment Separation behavior in pneumatic separator. 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.

AE4T07 – Engineering Thermodynamics & Heat Engines **(2– 0 – 0 – 2)**	
Unit - I	Thermodynamics properties, closed and open system, low 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
Unit - II	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.
Unit - III	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.
1. 2. 3. 4.	**Books:** .Nag, P.K., Engine Thermodynamics, 2nd editions, Tata McGraw Hill, New Delhi, 2001. Zimmansky, M.W., & Dittman, R.H. Heat and Thermodynamics,, ISE 7th edition, McGraw Hill, New York, 1977. Gill, P.W., Smith, J.H., and Ziurys, E.J., Fundamentals of Internal Combustion Engine,, 1st edition, Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi, 1954. Mathur, M.L. and Sharma, R. P., A course in Internal Combustion Engines, 1994 edition, Dhanpat Rai and Sons, Delhi-110006.

FIFTH SEMESTER

AE5T01 – Workshop Technology **(2 – 0 –0 – 2)**	
Unit - I	Introduction to welding, types of welding, Oxyacetylene gas welding, types of flames, welding techniques and equipment. Principle of arc welding, equipment and tools.
Unit - II	Casting processes. Classification, constructional details of center hole. 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.
Unit - III	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.
Unit - IV	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.
	Books: 1. Hajra Choudhury, Hajra Choudhury and Nirjhar Roy, Elements of Workshop Technology, 12th Ed, Vol. 1 & 2, Media Promoters & Publishers Pvt. Ltd. 2007. 2. W. A. J. Chapman, Workshop Technology, Part I, II & III, Viva Books Private Ltd, 2004.

AE5T02 – Machine Design **(2– 0 –0 – 2)**	
Unit - I	Meaning of design, Phases of design, design considerations. Common engineering materials and their mechanical properties.
Unit - II	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.
Unit - III	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
	Books: 1. Shiegley and Mischke, Mechanical Engineering Design,, McGraw Hill International, 2. Auckland, 1998. 3. Spott, MF, Design of Machine elements, Prentice Hall Of India, New Delhi, 1998. 4. Bandari, V.B., Design of Machine elements, Tata McGraw Hill, New Delhi, 1998. Nortron, Design of Machinery, McGraw Hill International, Auckland, 1999.

AE5T03 – Heat and Mass Transfer **(2 – 0 – 0 – 2)**

Unit - I	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.
Unit - II	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.
Unit - III	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.
Unit - IV	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.
Unit - V	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.
	Books: 1. Fellows, P.J. Woodhead PubFood Processing Technology Principles & Practice. New Delhi, 3rd edition, 2009 2. Brennan, J.G., Butters, J.R., N.D.Cowell & Lilly, A.E.V., Food Engineering Operations, Elsevier pub. 3rd edition. 3. Timoshenko, Heat and mass transfer, 4. Geankoplis, C.J. Transport processing and unit operation,, 3rd edition, prentice Hall India, 1993.

AE5T04 – Farm Machinery and Equipment **(2 – 0 –1 – 3)**	
Unit - I	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.
Unit - II	Tillage; primary and secondary tillage equipment. Design of farm machinery equipment. Forces acting on tillage tools. Hitching systems and controls. Draft measurement of tillage equipment.
Unit - III	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. Crop harvesting machinery, Root crop harvesting equipment. Instrumentation for testing of farm machinery. Ergonomics and its application on farm equipment design.

	Books:
1.	Principles of Farm Machinery, R.A. Kepner, Roy Bainer and E.L. Berger, 1st edition, CBS Publishers and Distributors, New Delhi, 1987.
2.	Farm Machinery and Equipment, 6th edition H.P. Smith and L.H. Wilkis, Tata McGraw Hill Publishing co. Ltd. New Delhi, 1988.
3.	Farm Machinery, C. Culpin, 11th edition, Crosby Publications, London, 1986.
4.	Principles of Agricultural Engineering, Vol. 1, A.M. Michael and T.P. Ojha, 3rd edition, Jain brothers, New Delhi, 1978.
5.	Moving of Earth, Work Book of Excavation, 3rd edition, Herbert L. Nicholas, North Castle Books, Connecticut, 1955.

AE5L01 – Farm Machinery and Equipment Lab **(1)**	
1.	Introduction to various farm machineries, visit to implements shed and research hall.
2.	Field capacity and field efficiency measurement for atleast two
3.	rnochlness/implements.
4.	Draft and fuel consumption measurement for different implements under different soil condition.
5.	Construction details adjustments and working of M.B. plow, disc plow and disc
6.	harrow and secondary tillage tools. Introduction, construction and working of earth moving equipments.
7.	Construction and working of rotavators and other rotary tillers, measurement of speed
8.	and working width.
9.	Working of seed-cum-fertilizer drills, planters and their calibration in field.
10.	Working of transplanter and operation. Weeding equipments and their use. Study of sprayer, duster, measurement of nozzle discharge, field capacity etc.

AE5T05 – Ground Water Wells and Pumps **(2 – 0 –0 – 2)**	
Unit - I	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 groundwater potential, quality of ground water, artificial groundwater recharge planning, modeling, ground water project formulation.
Unit - II	Pumping Systems: Water lifting devices; different types of pumping machinery, classification of pumps, component parts of centrifugal pumps; pump selection, installation and troubleshooting; 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,

	rotor dynamic pumps for special purposes such as deep well turbine pump and submersible pump
	Books: 1. Michael, A.M., Khepar, S.D., Water Well and Pump Engineering, Tata McGraw Hill Publishing Co. Ltd. New Delhi, 1989. 2. Tood, D.K., Ground Water Hydrology, John Wiley and Sons, New York, 2nd edition, 3. 1995. Raghunath, H.M., Ground Water, Wiley Easten Ltd. New Delhi, 1982.

AE5L02 – Ground Water Wells and Pumps Lab **(1)**	
1. 2. 3. 4. 5. 6. 7.	Study of Soil sampling technique Determination of porosity of soil sample Determination of hydraulic conductivity using Grain Size Analysis (GSA) method Determination of hydraulic conductivity of soil using falling head permeameter Determination of hydraulic conductivity of soil using constant head permeameter Cooper-Jacob method of approximation to solve unsteady state flow of water to wells Demonstration of Centrifugal pumps

AE5T06 – Drying and Storage Engineering **(3 – 0 –0 – 3)**	
Unit - I	Concept of water activity of food. 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. Psychrometry; Grain drying and drying equipment.
Unit - II	Types and functional requirements of storage structures. Grain pests and rodents control. Pressure theory in grain storage. Grain flow behaviour in storage structure. Aeration and fumigation in storage structure. Scheduling of aeration.
Unit - III	Design features of various storage structures: controlled atmospheric storage, modified atmosphere storage, cold storage and frozen storage. Management of cold storage.
	Books: 1. Sahay, K.M. & Singh, K.K. Unit operations of Agricultural Processing, , Vikas publishing house, New Delhi, 2nd edition, 2001 2. Chakraborty,, A. Post Harvest Technology of cereals, pulses & Oil seeds, Oxford & IBH Pub. New delhi, 3rd edition, 2000 3. Chakraverty, A., Mujumder, A. S., Raghavan, G. S. V. & Ramaswamy, H.S. Handbook of Post Harvest Technology, Cereals, Fruits, Vegetables, Tea and Spices, star 4. Educational book distributor, pvt. Ltd. New Delhi, 2010 5. Michael, A. M. & Ojha, T. P. Principles of Agricultural Engineering-I, Jain Brothers

	Publ. New Delhi, 2006 Handling & Storage of Food Grains, Food and Agriculture organization of the U.N, Rome 3rd edition, oxford IBH Pub, New Delhi, 1980

AE5L03 – Drying and Storage Engineering Lab **(1)**	
1. 2. 3. 4. 5. 6. 7. 8. 9. 10. 11. 12.	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 characteristics 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 structure. Visits to commercial handling and storage facilities for grains.

AE5T07 – Soil and Water Conservation Engineering **(3 – 0 –0 – 3)**	
Unit - I	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.
Unit - II	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.
Unit - III	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 & shelterbelts, 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 waterways and their design; introduction to water harvesting; introduction to stream water quality and pollution.

	Books:
1.	Schwab, G.O., Frevert, R.K., Edminster, T.W., Barnes, K.K., Soil and Water Conservation Engineering, 3rd edition, John Wiley and Sons, New York, 1981.
2.	Lurthy, V.V.N., Land and Water Management Engineering, 2nd edition, Kalyani Publishers, Ludhiana, 1985.
3.	Mal, B.C., Introductory Soil and Water Conservation Engineering, Kalyani Publishers, Ludhiana, 1995.
4.	Batsford, B.T., Soil Conservation, Norman Hudson, London, 1981.
5.	Suresh, R., Soil and Water Conservation Engineering, 2nd edition, Standard Publisher
6.	and Distributors, New Delhi., 1997.
	Das, G., Hydrology and Soil Conservation Engineering, Prentice Hall of India Pvt. Ltd. New Delhi, 2000.

AE5L04 – Soil and Water Conservation Engg. Lab **(1)**	
1.	Study of soil loss measurement technique.
2.	Study of details of Coshocton wheel and multi- slot runoff sample.
3.	Determination of sediment concentration through oven dry method.
4.	Problems on Universal Soil Loss Equation.
5.	Preparation of contour map of an area and its analysis.
6.	Design of vegetative waterways.
7.	Design of contour bunding system.
8.	Design of grade bunding system.
9.	Design of various types of bench terracing system.
10.	Determination of rate of sedimentation and storage loss in reservoir.
11.	Design of shelter belt and windbreaks.

SIXTH SEMESTER

AE6T01 – Agriculture for Engineers **(3 – 0 –0 – 3)**	
Unit - I	Soils: Nature and origin of soil; soil forming rocks and minerals, their classification and composition, soil forming processes, classification of soils, soil taxonomy orders; important soil physical properties; and their importance; soil particle distribution; soil inorganic colloids, their composition, properties and origin of charge; ion exchange in soil and nutrient availability; soil organic matter, its composition and decomposition, effect on soil fertility; soil reaction, acid, saline and sodic soils; quality or irrigation water; essential plants nutrients , their functions and deficiency symptoms in plants; important inorganic fertilizers and their reactions in soils.
Unit - II	Agronomy: Definition and scope of agronomy. Classification of crops, Effect of different weather parameters on crop growth and development. 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.
Unit - III	Horticulture: Scope of horticultural and vegetable crops. Soil and climatic requirements for fruits, vegetables and floriculture crops, improved varieties, Criteria for site selection, layout and planting methods, nursery raising, macro and micro propagation methods, plant growing structures, pruning and training, fertilizer application, fertigation, irrigation methods, harvesting, grading and packaging, post harvest practices, Garden tools, management of orchard, Extraction and storage of vegetables seeds.
Unit - IV	Planning and layout of farmstead. Physiological reactions of livestock to solar radiation and other environmental factors, livestock production facilities, BIS. Standards for dairy, piggery, poultry and other farm structures. Design, construction and cost estimation of farm structures; animal shelters, compost pit, fodder silo, fencing and implement sheds, barn for cows, buffalo, poultry, etc. Design and construction of rural grain storage system Engineering for rural living and development, rural roads, their construction cost and repair and maintenance.
	Books: 1. Handbook of Agriculture, ICAR 2. Agronomy, Shagufta, APH Publishing cooperation, 2001 3. Handbook of Horticulture, Jain Book Agency, 2004

AE6T02 – Refrigeration & Air Conditioning **(2 – 1 –0 – 3)**	
Unit - I	Principles of refrigeration, second law of thermodynamics applied to refrigeration, carnot cycle, reversed Carnot cycle, coefficient of performance, unit of refrigeration.
Unit - II	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.

Unit - III	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.
Unit - IV	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.
	Books: 1. Refrigeration and Air Conditioning – C.P. Arora, TMGH. 2. Refrigeration and Air Conditioning – Manohar Prasad, New Age International. 3. Refrigeration and Air Conditioning – P.L. Ballaney, Khanna Publishers. 4. Principles of Refrigeration and Air Conditioning – Jordan and Prister, MGH.

AE6T03 – Transfer Process in Food Engineering **(3 – 0 –0 – 3)**	
Unit - I	Introduction to transfer process. Steady state conduction, convection and radiation heat transfer, equations for radiative, convective and overall heat transfer for various geometries.
Unit - III	Unsteady state heat transfer in objects simple geometry, Heat Exchangers: Heat Exchanger-types and constructional details, parallel, counter flow and cross flow H.E, LMTD, effectiveness, NTU, use of charts for LMTD and LTU calculations. Design of double pipe, shell and tube and plate heat exchangers. Newtonian, and non-Newtonian fluids, laminar and turbulent flow through pipes and plates; Navier Stoke's equation; fanning's friction factor. Velocity profile of fluid flow. Turbulent flow.
Unit - III	Introduction to mass transfer and their application in food engineering. Diffusive and convective mass transfer. Mass transfer through packaging materials. Simultaneous heat and mass transfer in agricultural processing operations.
	Books: 1. Geankopolis, C.J. Transport Process and Unit Operations, , 3rd edition, Prentice Hall of India, New Delhi, 1999. 2. Halman, J.P. Heat Transfer, 8th edition, McGraw Hill Book Co. New York, 1977. 3. Bird, Steward and LightFoot,Transport Phenomena, 8th edition, John Wiley and Sons, New York, 1977. 4. Ozisik, M.N. Heat transfer- A Basic Approach, McGraw Hill Book Co., New York, 1985.

AE6T04 – Tractor Systems & Control **(2 – 0 –0 – 2)**	
Unit - I	Study of transmission systems. Function, Principle of operation of clutch system, working of single plate system, detail of components, working of dual clutch plate system & clutch adjustment.

Unit - II	Gear box: Introduction, principle of gearing & types of gear box. Differential: Function, principle of operation, operational details and differential lock, Final drive. Familiarization of brake mechanism, mechanical and hydraulic brake, Tractor power outlets: P.T.O., belt pulley, drawbar, etc. Ackerman and hydraulic steering, Tractor hydraulic systems and hitching. Tractor chassis mechanism and design of tractor stability. Introduction to traction and traction theory, Ergonomic considerations and operation safety. Differential: Function, principle of operation, operational details and differential lock, Final Drive.
Unit - III	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.
	Books: 1. Elements of Agricultural Engineering by Dr. Jagdiswar Sahay (S). 2. Farm Tractor Maintenance and Repair, S.C. Jain & C.R. Rai (J). 3. Principles of Agricultural Engineering-I, A M Michael & T P Ojha, Jain Brothers Publ. 4. New Delhi, 2006 Farm Machines & Equipments, CP Nakra, Dhankpat Rai & Sons (N)

AE6L01– Tractor Systems & Control Lab **(1)**	
	1. To dismantle and measure the wear and tear of clutch plate 2. To dismantle and assemble of different types of gear box 3. To measure the backlash of differential gears 4. To dismantle and study the working of the hydraulic brake 5. To dismantle and study the P.T.O. shaft and its uses with different type of farm 6. implements and machine 7. To study about the different types of drawbar in a tractor To assess the ergonomics that are incorporated with the tractor To visit to an engineering workshop and prepare a report on power transmission system

AE6T06 – Irrigation and Drainage Engineering - I **(2 – 0 –0 – 2)**	
Unit - I	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.
Unit - II	Soil Water plant relationship, soil water movement, infiltration, evapo-transpiration, soil moisture constant, depth of irrigation, frequency of irrigation, irrigation efficiencies.

Unit - III	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.
	Books: 1. Michael, A.M., Irrigation theory and practice, 2nd revised and enlarged edition, vikas pub. House, New Delhi, 2008. 2. Singh, B., Fundamentals of irrigation engineering, 8th edition, New chand and brothers, Roorkee, 1997.. 3. Birdie, G.S., Das, R.C., Irrigation engineering, 2nd edition, Dhanpat Rai & sons, New Delhi, 1996. 4. Basak, N.N., Irrigation engineering, Tata McGraw hill pub., co., Ltd., New Delhi, 2001. 5. Garg, S.K., Irrigation engineering and hydraulic structures, Khanna Pub., New Delhi., 6. 1999. Luthin, J.N. Drainage Engineering, John Wiley and Sons, New York, 1970.

AE6L02– Irrigation and Drainage Engineering Lab (1)	
1.	Field and Laboratory demonstration of hydro-met observatory, flow measurement
2.	Flow measurement using V-notch weir
3.	Demonstration of Parshall Flume
4.	Determination of discharge using Orificemeter
5.	Determination of discharge using Venturimeter
6.	Demonstration of Reynold's Apparatus
7.	Design of subsurface drainage system.
8.	Determination of chemical properties of soil and water.

Elective – I

AE6EL01 – Agribusiness Management and Trade(3 – 0 –0 – 3)	
Unit - I	Basics of agri-business management; planning, Organising, Controlling, Leading.
Unit - II	Forecasting for agri-business; location and Layout of facilities, Workforce management.
Unit - III	Quality management, Maintenance management.

Unit – IV	Financial analysis of agri-business.
Unit - V	Process Strategy; inventory management.
	Books: 1. **Rajgopal,** Agri-business and Entrepreneurship,Indian Book & Periodicals, new Delhi, 2. 1990. 3. R.S. Jalal, Agribusiness and rural Developmentl, Indian Book & Periodicals, New delhi, 1991. Johl, S.S., & Kanpur, R.R, Fundamentals of Farm Business Management_, kalyani Publishers, Ludhiana, 1997.

AE6EL02 – Entrepreneurship Development and Communication Skills **(3 – 0 –0 – 3)**	
Unit - I	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. Globalization and the emerging business/entrepreneurial environment. Concept of entrepreneurship; entrepreneurial and managerial characteristics; managing on 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.
Unit - II	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.
Unit - III	Communication Skills: Structural and functional grammar; meaning and process of communication, verbal and non-verbal communication; listening and note taking, writing skills, oral presentation skills field diary and lab record; indexing, footnote and bibliographic procedures. reading and comprehension of general and technical articles, précis writing, summarizing, abstracting; individual and group presentations, impromptu presentation, public speaking; Group discussion. Organizing seminars and conferences.
	Books: 1. **Rajgopal,** Agri-business and Entrepreneurship,, Indian Book & Periodicals, New Delhi, 2. 1990. Jalal, R.S., Industrial Entrepreneurship & small Scale Industries_, Indian book & 3. Periodicals, New Delhi, 1991. Rathore, B.S & Saini, J.S., Entrepreneurship development_, wiley eastern Ltd. New delhi, 1991.

AE6EL03 – Design and Maintenance of Greenhouse **(3 – 0 –0 – 3)**	
Unit - I	History and types of greenhouse; importance, function and features of green house; scope and development of greenhouse technology.
Unit - II	Location, Planning and various components 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.
Unit - III	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.
Unit - IV	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
	Books: 1. Rick Fisher, Bill Yanda, The Food and Heat Producing Solar Greenhouse, Design, Construction, Operation, John Muir Publisher, 1980. 2. Integrated Greenhouse Systems for Mild Climates, Christian von Zabeltitz, 2011.

AE6EL04 Soil and water Conservation Structure **(3 – 0 – 0 – 3)**	
Unit - I	Introduction; classification of structures, functional requirements of soil erosion control structures; runoff measuring structures-parshall flume, H - flume and weirs;
Unit - II	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.
Unit - III	Drop inlet spillway- general description, functional use, design criteria; design of diversions;Chute spillway general description and its components, hydraulic design, energy dissipaters, design criteria of a SAF stilling basin and its limitations,
Unit - IV	Small earth embankments-their types and design principles, farm ponds and reservoirs, cost estimation of structures.

	Books:
1.	**Schwab, G.O., Frevert, R.K., Edminster, T.W., and Barnes, K.K.** Soil and Water Conservation Engineering,, 3rd edition, John Wiley and Sons, New York, 1981.
2.	Murthy, V.V.N., Land and Water Management Engineering, 2nd edition, Kalyani Publishers, Ludhiana, 1985.
3.	Mal, B.C., Introductory Soil and Water Conservation Engineering,. Kalyani Publishers, Ludhiana, 1995.
4.	Soil Conservation, Norman Hudson, B.T. Batsford, London, 1981.
5.	Suresh, R. Soil and Water Conservation Engineering, 2nd edition, Standard Publisher and Distributors, New Delhi., 1997.
6.	Ghanshyam Das. Hydrology and Soil Conservation Engineering,, Prentice Hall of India Pvt. Ltd. New Delhi, 2000.

AE6EL05 – Environmental Pollution **(3 – 0 –0 – 3)**	
Unit - I	Introduction of Pollution in the Environment, Sources of Pollutants in Soil, Water, and Atmosphere
Unit – II	Quantification of Chemical Pollutants, Implications due to various pollutants present in the environment, Emerging pollutants in the environment
Unit – III	Analysis of Environmental Pollutants, Pollutants Control Strategies, Biochar application
	Books:
1.	Masters M.G., Ela W.P., Introduction to Environmental Engineering and Science. Pearson, 3rd Ed. 2015.
2.	Hill M.K., Understanding Environmental Pollution. Cambridge University Press, 3rd Edition. 2010.
3.	Jacobson M.J., Atmospheric Pollution, History, Science and Regulation. Cambridge University Press. 2002.

SEVENTH SEMESTER

AE7T01 – Irrigation and Drainage Engineering – II **(2 – 0 –0 – 2)**	
Unit – I	Surface irrigation methods of water application, border, check basin; furrow and counter irrigation; sprinkler and drip irrigation method, merits, demerits, selection and design; Participatory irrigation management. Economics of water resources utilization.
Unit – II	Investigations of design parameters, hydraulic conductivity, drainable porosity, water table etc., types and use of subsurface drainage system, Design of subsurface drains, interceptor and relief drains. Derivation of ellipse (Hooghoudt's) and Ernst's drain spacing equations. Design of subsurface drainage system.
Unit – III	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.
	Books: 1. Michael, A.M., Irrigation theory and practice, 2nd revised and enlarged edition, Vikas pub. House, New Delhi, 2008. 2. Singh, B., Fundamentals of irrigation engineering, 8th edition, New Chand and brothers, Roorkee, 1997.. 3. Birdie, G.S., Das, R.C., Irrigation engineering, 2nd edition, Dhanpat Rai & sons, New Delhi, 1996. 4. Basak, N.N., Irrigation engineering, Tata McGraw hill pub., co., Ltd., New Delhi, 2001. 5. Garg, S.K., Irrigation engineering and hydraulic structures, Khanna Pub., New Delhi., 6. 1999. Luthin, J.N., Drainage Engineering, , John Wiley and Sons, New York, 1970.

AE7T02 – Mechanics of Tillage and Traction **(2 – 0 –0– 2)**	
Unit - I	Introduction to tillage and mechanics of tillage tools, engineering properties of soil, principles and concepts, stress strain relationship.
Unit - II	Application of soil dynamics in tillage, assessment of dynamic properties of soil: Laboratory method and direct field method. Soil cutting, Design of tillage tools,
Unit - III	Shear and Compressive Strength of Soil: Soil failure criteria, boundary stress and stress conditions, retaining wall theory and its application in the design of soil engaging components, general and compressive soil failures. 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.
	Books: 1. W.R and GVandenberg, G.E., Soil Dynamics in Tillage and Traction, ARS, USDA, 2. 1968. 3. Bekker, M.G & Ann Arbor, Theory of Land Locomotion, The University of Michigan

	Press, U.S.A. 1956. 4. E. McKeyes Elsevier, Soil Cutting and Tillage, Tokyo, 1985. Wong, J.Y, John Wiley and Sons Inc., Theory of Ground Vehicles, New York, 1993.

AE7L01– Mechanics of Tillage & Traction Lab **(**	
1. 2. 3. 4. 5. 6. 7.	Measurement of wheel slip. To measure the soil strength of the soil using a cone penetrometer. To study different types of tractor tires. Determination of shear parameters by Direct shear test. Determination of shear parameters by Triaxial test. To determine the physical properties of soil. To study the method of ballasting.

AE7T03 – Unit Operation in Dairy and Food Engineering **(2 – 0 –0 – 2)**	
Unit - I	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, pasteurization, sterilization, homogenization, drying filling &packaging, butter manufacture, dairy plant design and layout. Material and energy balances involving solids, liquids and gases in dairy & food processing systems.
Unit - II	Contact equilibrium separation process: Concept of mass transfer in unit operations. Theory of equilibrium. Distillation, solid liquid extraction, gas absorption, adsorption, crystallization, humidification and dehumidification. Membrane separation. Simultaneous heat & mass transfer: Drying, different drying methods: conduction, convection & radiation drying. Microwave drying, Irradiation. Evaporation: method & design concept, steam economy. Material handling: Methods & design concept.
	Books: 1. Kessler, H.G., Kessler, V.A. & Freising. Food Engineering and Dairy Technology, , 2. Germany 1981. Toled, R.T. Fundamentals of Food Process Engineering, 2nd edition, CBS Publishers 3. and Distributors, New Delhi, 1997. Geankopolis, C.J. Transport Processes and Unit Operations, 3rd edition, Prentice Hall of 4. India, New India, 1999. Butters Cowell and Lilley,Food Engineering Operations, Brennan, 3rd edition, Elsevier

	Applied Science, Amsterdam, 1900.

AE7L02– Unit Operation in Dairy and Food Engineering Lab (1)	
1.	Study of composite pilot milk processing plant & equipments.
2.	Study of pasteurizers &sterilizers.
3.	Study of homogenizers.
4.	Study of separators.
5.	Study of butter churners.
6.	Study of evaporators.
7.	Study of milk dryers.
8.	Study of freezers.
9.	Visit to multiproduct dairy product.
10.	Visit to food industry.

AE7T04 – Statistical Hydrology (2 – 0 –0 – 2)	
Unit - I	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 - II	Probability: Sample space, conditional probability, independent variables and independent experiments, Baye's theorem, Random variables (continuous and discrete), probability density function, cumulative distribution function, moment generating function. Probability distributions-Binomial, Poisson, Normal. Sampling, Sampling distribution, standard error, Student's t-distribution, Chi-square test as a test of goodness of fit. Unit hydrograph method; Statistics in hydrology, flood frequency methods - Log normal, Gumbel's extreme value, Log-Pearsontype-1, 1 distribution; depth-area-duration analysis.
	Unit hydrograph method; Statistics in hydrology, flood frequency methods - Log normal, Gumbel's extreme value, Log-Pearsontype-1, 1 distribution; depth-area-duration analysis.
Unit - III	Flood forecasting, flood routing - channel routing, Muskingum method, reservoir routing, modified Paul's method; flood control - history of flood control, structural and non-structural methods of flood control measures, storage and detention reservoirs, levees, channel improvement.
	Books:
1.	Dhruvanarayana, V. V., Soil and Water Conservation Research in India. ICAR, New Delhi. 1993.
2.	Goldman, S. J, Jackson K. and Bursztynsky, T. A., Erosion and Sediment Control Handbook. McGraw- Hill Book Company. 1986.
3.	Murthy, V.V.N.,. Land and Water Management. Kalyani Publishing, New Delhi. 1998.

Elective – II (AE7EL__)

AE7EL01 – Remote Sensing and GIS Application **(3 – 0 –0 – 3)**	
Unit - I	Remote sensing: definition, stage in remote sensing, modern remote sensing technology versus conventional aerial photography: visual image interpretation, image interpretation, basic principles of image interpretation.
Unit - II	Factors governing the quality of the image: factors governing interpretability, visibility of objects, elements of image interpretation, techniques of image interpretation, digital image processing, digital image : remote sensing in agricultural progress and prospects, microwave radiometry for monitoring agricultural crops and hydrologic forecasting: aerial photo interpretation for water resources development and soil conservation survey.
Unit - III	GIS: history of development of GIS. definition, basic components, and standard GIS packages: data – Entry, storage and maintenance: Data types- spatial- non- spatial (attribute data), data structure, data format- point line vector- raster- polygon object structural model- files- files organization- data base management systems (DBMS), entering data in computer digitizer- scanner- data compression.
	Books: 1. Barret, E.C., and Curtis, L.F., Introduction to Environmental Remote Sensing. Chapman and Hall, London 3rd Edition, 1992. 2. Manggi Reddy, Remote Sensing and Geographical Information System:, B.S. Publication, 2nd Edition, 2002. 3. Lillesand, L.M., and Keifer, R.W., Remote Sensing and Image Interpretation, John Willey and Sons Inc., New York, 2000 4. DeMers, M.N., Fundamentals of Geographical Information System,. John willey & Sons, 2nd Edition, 1999.

AE7EL02 – Tea Technology **(3 – 0 –0 – 3)**	
Unit - I	Soil and climate, plant propagation and nursery management, Soil Preparation for tea plantation
Unit - II	Fertilizer application, irrigation and drainage systems for tea plantation. Plucking, shifting and pruning machines
Unit - III	Tea Processing: Chemistry of tea processing and manufacturing, working principles of processing equipment and their maintenance. Human resource management. Transport and marketing, warehousing, testing and sale etc.
	Books: 1. Environmental Engineering, G.N.Pandey, G.C.Carney, Tata MacGraw Hill Co. New 2. Delhi, 1994. 3. Environmental Engineering, Gepard Kiely, MacGraw Hill international, New York, 1998. Environmental Pollution Control Engineering, C.S.Rao, New Age International, New Delhi, 2001.

AE7EL03 – Development of Processed Product & Equipment **(3 – 0 –0 – 3)**	
Unit - I	Application of unit operations to food industry, analytical processing concepts with regard to mass and energy balances, equipment involved in the commercially important food processing methods and unit operation: valve addition to cereals like rice , wheat etc. parboiling of rice, quality of processed products of rice and wheat. Processing of pulses, spices and condiments: Extruded food product, fermented food product, frozen and dried product, technology of meat, fish and poultry product, technology of milk and milk products.
Unit - II	Technology of oil seeds and fat product, snack foods, fruits and vegetables product: candy, nutraceuticals, food product development trends, food additive and labeling.
Unit - III	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.
	Books: 1. Food Engineering and Dairy Technology, H.G. Kessler, V.A. Kessler, Freising, 2. Germany 1981. Fundamentals of Food Process Engineering, R.T. Toled, 2nd edition, CBS Publishers and 3. Distributors, New Delhi, 1997. Unit operations of Agricultural Processing, K.M. Sahay& K.K. Singh, Vikas publishing 4. house, New Delhi, 2nd edition, 2001 Post-Harvest Technology of cereals, pulses & Oil seeds, A Chakraborty, Oxford & IBH Pub. New delhi, 3rd edition, 2000

AE7EL04 – Waste and By-product Utilization **(3 – 0 –0 – 3)**	
Unit - I	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.
Unit - II	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.
Unit - III	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.

	Books: 1. Food from waste, Warvan. 2. Food protein sources, Pirie. 3. Technology of fish utilization, Ed. Kreuyer.

AE7EL05 – Food Processing Plant Design & Layout **(3 – 0 –0 – 3)**	
Unit - I	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.
Unit - II	Location selection criteria, selection of processes, plant capacity, project design, flow diagrams, selection of equipments, process and controls, handling equipments, plant layout.
Unit - III	Plant elevation, requirement of plant building and its components, labor requirement, plant installation, power and power transmission, sanitation. Cost analysis, preparation of feasibility report.
	Books: 1. Reddy, R.N. Agricultural process engineering, , Daya Pub. House, 2010 2. Rao, D.G. Fundamentals of Food engineering, Phi Learning Pub. 2010 3. Singh R, Introduction to Food Engineering, 3rd Edition, Academic Press, 2001

AE7EL06 – Contaminant Hydrology **(3 – 0 –0 – 3)**	
Unit - I	Basics of groundwater flow: hydrogeologic properties, Darcy's equation, flow equations, equipotential lines.
Unit - II	Unsaturated flow: unsaturated zone flow properties, soil-moisture characteristics (lab work), non-linear flow equations. Density Driven Flow: Freshwater/Saltwater Interaction, Heat Transport and Groundwater Flow, Role of Groundwater in Large-scale Water and Chemical Budgets
Unit - III	Flow and transport: transport processes, equations, simulation of fate and transport processes (modeling exercises).
	Books: 1. Domenico, P.A., Schwartz, F.W., Physical and Chemical Hydrogeology, Wiley 1997, ISBN: 978-0471597629. 2. Fetter, C.W., Applied Hydrogeology, Macmillan USA, 1993, ISBN: 978-0023364907. 3. Freeze, A.W., Cherry, J.A., Groundwater, Prentice Hall, 1979, ISBN: 978-0133653120.

EIGHT SEMESTER

AE8T01 – Tractor Design and Testing **(2 – 0 –0 – 2)**	
Unit - I	Importance of testing. Types of test-confidential, commercial and batch. Testing facilities in India and abroad. O.E.C.D., Nabraska and I.S.I. test code for engine test, P.T.O. test, belt and pulley test, draw bar test, Hydraulic power and lifting capacity test.
Unit - II	Turing ability, visibility from driver's seat. Brake test, air cleaner, oil pull over test, noise measurement, vibration measurement, assessment of power drop and wear. Testing of various farm machineries and their main components for functional performance, wear, strength, force and power requirement.
	Books: 1. Barger, E.L., Liledahl, J.B., Carleton, W.M.and Mckibben, E.G. (1978). Tractor and their power units. Wiley Eastern pvt. Ltd, New York. 2. Kanafoshi, C.Z. and Karwawshi, T. (1976). Agricultural Machines, Theory and Construction (Vol. 1 and 2). USDA, Poland. 3. Pandya, N.C. and Shah, C.S. (1981). Elements of Machine Design. Charotar Publishing House, Anand.

AE8T02 – Food Process and Packaging Technology **(3 – 0 –0 – 3)**	
Unit - I	Thermal processing of foods: Kinetics of microbial death, process calculations for caning, pasteurization and sterilization of foods. Concept of minimal food processing. Chemical preservatives. Food preservation by fermentation, curing, pickling, smoking etc; use of enzymes in food processing. F&V technology: Concept of fruits & vegetables preservation, dryig technology. Technology of beverages.
Unit - II	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.
Unit - III	Food packaging materials, Food packaging methods. Effects of processing on quality of foods. Indian food laws. HACCP & GMP concept. 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. Disposal and recycle of packaging waste.
	Books: 1. Ahvenainen, R. Novel Food Packaging Techniques, Woodhead pub. Ltd., New York, 2. 2000 Chakraverty, A., Mujumder, A.S., Raghavan, G. S. V., & Ramaswamy, H. S .Handbook 3. of Post-Harvest Technology, Cereals, Fruits, Vegetables, Tea and Spices, star Educational book distributor, pvt. Ltd. New Delhi, 2010 4. Rajarathnam, S. & Ramteke, R. S. Advances in Preservation & Processing Technologies

	of Fruits & Vegetables, New India Pub Agency, New Delhi, 2011 Berk, Z. Food Process Engg.& Technology, 1st edition, Elsevier, New York, 2009

AE8T03 – Watershed Planning and Management **(2 – 0 –0 – 2)**	
Unit - I	Watershed management - problems and prospects; watershed based land use planning, watershed characteristics - physical and geomorphologic, factors affecting watershed management.
Unit - II	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.
Unit - III	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.
	Books: 1. Murthy, J.V.S., Watershed Management, New age International Publishers. 2. Awurbs, R. and James, W.P. Water Resource Engineering, Prentice Hall Publisher. 3. I.W. Heathcote, John Wiley & Sons, Inc, Integrated Watershed Management, Principles and Practice., New York, 1988. 4. R. Lal – CRC Press, Integrated Watershed Management in the Global Ecosystem, Boca Raton, FL, 2000.

G8T01– India Constitution **(0– 0 –0 – NC)**	
Unit - I	Meaning of the constitution law and constitutionalism Historical perspective of the Constitution of India Salient features and characteristics of the Constitution of India
Unit - II	Scheme of the fundamental rights The scheme of the Fundamental Duties and its legal status The Directive Principles of State Policy – Its importance and implementation
Unit - III	Federal structure and distribution of legislative and financial powers between the Union and the States Parliamentary Form of Government in India – The constitution powers and status of the President of India

	Amendment of the Constitutional Powers and Procedure
Unit - IV	The historical perspectives of the constitutional amendments in India Emergency Provisions : National Emergency, President Rule, Financial Emergency Local Self Government – Constitutional Scheme in India

Elective – III

AE8EL01 – Human Engineering and Safety **(3 – 0 –0 – 3)**	
Unit - I	Human factors in system development - concept of systems; basic processes in system development, performance reliability, human performance.
Unit - II	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.
Unit - III	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.
	Books: 1. Grandjean, E, 1988, Fitting the Task to the Man, Taylor and Francis, London. 2. Sanders, M.S. and McCormick, E.J. 1978, Human Factors in Engineering and Design, McGraw Hill Inc, Singapore. 3. Griffin, M.J. 1996, Hand Book of Human Vibration, Academic Press.

AE8EL02 – Biomass Management for Fodder and Energy **(3 – 0 –0 – 3)**	
Unit - I	Introduction to biomass management, biomass resource assessment management techniques/supply chains.
Unit - II	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.
Unit - III	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.

	Books: 1. K.M. Sahay & K.K. Singh, Unit operations of Agricultural Processing, Vikas publishing house, New Delhi, 2nd edition, 2001 2. A Chakraborty, Post Harvest Technology of cereals, pulses & Oil seeds, Oxford & IBH Pub. New delhi, 3rd edition, 2000 3. Warvan, Food from waste.

AE8EL03 – Production Technology of Agricultural Machines **(3 – 0 –0 – 3)**	
Unit - I	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.
Unit - II	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 7 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.
Unit - III	Case studies of manufacturing of Agril. Machinery. Servo motors, drives 7 controllers, CNC controllers for machine tools. CNC programming. Assembly and plant automation. Storage and transportation.
	Books: 1. Theory of Ground Vehicles, J.Y. Wong, John Wiley & Sons Inc. New York, 1993 2. Rnam Test Codes and Procedures for Farm Machinery, 2nd Edition, UNIDO, 1995

AE8EL04 – Renewable Energy Source **(2 – 1 –0 – 3)**	
Unit - I	Classification of energy sources; Introduction to renewable energy sources.
Unit - II	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.
Unit-III	Brief introduction to wind energy, hydroelectric energy, ocean energy, briquetting and baling of biomass, biomass combustion, biodiesel preparation and energy conservation in agriculture.

	Books:
1.	G.D. Rai, Non-Conventional Sources of Energy, 4th edition, Khanna Publishers, Delhi
2.	1996.
3.	Saroj Prakashan, Non-Conventional Sources of Energy, O.P. Singhal, 1st edition,,
4.	Allahabad, 1996.
	S.P. Sukhatme, Solar Energy, 2nd edition, Tata McGraw Hill Publishing Co. Ltd. New Delhi, 1996.
	A. Chakraborty, Biotechnology, other Alternative Technologies for Utilization of Biomass/Agril. Wastes, 1st edition, Oxford and IBH Publishing Co. Pvt. Ltd, New Delhi, 1989.

AE8EL05 – Organic Farming for sustainable Agricultural Production **(2 – 1 –0 – 3)**	
Unit - I	Organic farming: Introduction and status, Organic Farming and its components. Organic farming concepts and principle. SWOT analysis of organic farming: Sustainable agriculture, key indicators of sustainable agriculture, organic farming and climate change.
Unit - II	Principles of compost production: Vermi compost production technology, enriched vermin compost production technology, vermi compost quality and marketing. Introduction to pest and disease management: Level "C" pest and disease management, Introduction to organic crop management, organic plantation crop management, organic meat production.
Unit - III	Introduction on transition to organic crop production, crop planning and rotation design in organic system. Integrated farming system and urban agriculture. Quality of organic food. Natural sources of anti-oxidant for health defend. Organic standards, organic certification process, marketing of organic products.
1.	**Study Link:** **https://nptel.ac.in/courses/126105014/1**

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NOTE: Above proposals have been passed by the 26th Academic Council (AC:26:7:1) held on 11th December 2018. These modifications will effect from academic session of 2019.