BIKANER TECHNICAL UNIVERSITY, BIKANER
बीकानेर तकनीकी विश्वविद्यालय, बीकानेर

PROGRAMME SULLABUS

Agriculture Engineering- 2022
Semester V to VIII

3RD YEAR – IV SEMESTER

AE-501 (DC) FARM MACHINERY AND EQUIPMENT – I

Contact Hour/ week	Credits
2 (Lecture)	2

Course Outcome: At the end of the course, the student will be able to:
CO1: To identify the need of farm mechanization in India.
CO2: Also equip the students with technical knowledge and skills required for the operation, maintenance and evaluation of Tillage, Sowing and intercultural operational machinery needed for agricultural farms.
CO3: To abreast the students with mathematical, experimental and computational skills for solving different field problems.
CO4: To develop skills in the students required to develop and modification of indigenous farm machines as per the need of the area and farmers.

Unit-I

Status of farm mechanization, Introduction to various farm operation, implement types. Classification of farm machines. Materials of construction. Tillage and its objectives.Field capacities, field efficiency and simple numerical problems.

Unit-II

Primary and secondary tillage equipment; Ploughs: Disc, Mouldboard, Subsoiler, Rotary tiller, disc harrow and Puddlers. Forces acting on Disc, M.B. Plough and disc harrow. Draft measurement of tillage equipment and simple numerical problems.

Unit-III

Crop planting methods: Sowing and planting equipment - their construction, metering mechanism, furrow openers, covering devices and metering mechanism for fertilizer applications, calibration and adjustments. Paddy transplanter and its construction. Simple numerical problems on seed drills and planters. Introduction to plot seed drills and precision planters.

Unit-IV

Methods and equipments for interculture and weed control. Introduction to plant protection equipment: Sprayers, dusters and their calibration,
Constructional features of different components and adjustments of knapsack and foot sprayers and rotary duster. Simple numerical problems on calibration of sprayers. Introduction to earth moving equipment, construction & working principles of Bulldozer and numerical problems on its output.

Suggested Readings

1. Bainer, R. Barger, E.L. and R.A. Kepner. (1997). Principles of Farm Machinery. John Wiley & Sons, Inc, New York.
2. A.C. Shrivastava et al. Principle of Farm Machinery ASAE publications.
3. H.P. Smith. (1977). Farm Machinery and Equipment, Tata Mc-Graw Hill Publishing Co. Ltd., New Delhi.
4. H Singh and O.S. Bindra. (1980). Pesticides and Application Equipment, Oxford & IBM publishing Co.
5. O.P. Singhal. Elements of Agricultural Engineering, Part I and II. SarojPrakashan, Allahbad.
6. FAO, Bulletin. (1977). Elements of Agricultural Machinery, volume I.
7. R.L. Peurifoy. Construction, Planning, Equipment and Methods.
8. Singh, S. Principles of Farm Machinery. DIPA, ICAR, KAB-I, New Delhi
9. Singh, Surendra. Farm Machinery Principle and Application. ICAR Publication.
10. Singh, Surendra and S.R. Verma. Farm Machinery Maintenance and Management. ICAR Pub.

AE-502 (DC) BUILDING CONSTRUCTIONS AND COST ESTIMATION

Contact Hour/ week	Credits
2 (Lecture)	2

Course Outcome: At the end of the course, the student will be able to:
CO1: Demonstrate knowledge of various components of building,Foundations & Masonry constructions.
CO2: Determine concrete properties and demonstrate knowledgeof Earthquake management.
CO3: Estimate cost of a simple building & valuations.
CO4: Understand the working organization structure of engineeringdepartments.

(A) BUILDING CONSTRUCTION

Unit-I

Components of a building and their function.
Foundation: Function, shallow and pile foundation. Causes of failureand remedial measures.
Masonry Construction: English bond and Flemish bond for one bricksthick wall.
Stone Masonry: Types of stone masonry, Essentials of good stonemasonry.

Unit-II

Concept in Concrete Technology and test on concrete.
Load Carrying Floors: Types, stone patti, timber and R.C.C. floors.
Floor Finishing: Lime, Cement concrete, terrazzo, marble and P.V.C. tiles, details of construction.
Roofs: Simple roof trusses, king post roof truss, queen post roof truss.
Earthquake Disaster Management: Introduction, causes of earthquake, their intensities, its effect, safety measures and precautions to face earthquake problem.

(B) COST ESTIMATION

Unit-III

Object, Main item of works, the unit of measurement for various item of works & materials.Various methods of building estimate i.e. long wall-short wall methods &centre line method for one & two room building.

Unit-IV

Organization of Engineering Department: General discussion of P.W.D. accounting & procedure of works classification of work. Contract & contact document. Tender Notice- how to invite tender notice. Opening of tender & various conditions to accept it. Running & Final bill, Earnest money, Security money & measurement book.
Valuation: Purpose of valuation, Outgoings, Scrap value, Salvage value, Market value, Book value, annuity capitalized value, Methods of calculating deprecation, Sinking fund deprecation, Valuation of building.

Suggested Readings

1. S.P. Arora and Bindra. Building Construction. Dhanpat Rai & Sons, New Delhi
2. S.N. Awaasthy. Building Construction, Publishing House, Bhopal.
3. B.N. Datta. (1994). Estimating & Costing in Civil Engineering, Theory & Practice, Publishing Distributors Ltd., New Delhi.

AE-503 (DC) TRACTOR SYSTEMS AND CONTROLS

Contact Hour/ week	Credits
2 (Lecture)	2

Course Outcome: At the end of the course, the student will be able to:
CO1: Gaining knowledge about various tractor systems, their construction and working.
CO2: Learning fundamentals of tractor chassis design and traction theory.

Unit-I

Study of transmission system: Functions of transmission, Clutch:single and multiple clutches and their functions, Gear box: sliding and constant mesh, differential and final drive mechanism. Simple numerical problemson calculation of speed ratios.

Unit-II

Familiarization of brake mechanism: Mechanical and hydraulic. Steering: Ackerman and hydraulic. Hydraulic system of tractor: Automatic position and draft control.

Unit-III

Tractor power outlets: P.T.O., belt pulley, drawbar. Introduction to traction mechanics. Tractor chassis mechanics: C.G. determination and weight transfer. Simple numerical problems on tractor chassis mechanics.

Unit-IV

Tractor stability: Grade and non-parallel pull, turning at high speed. Simple numerical problems on tractor stability. Introduction to ergonomic considerations: Anthropometry and physiological cost measurements and tractor safety. Introduction to advances in tractor systems and controls.

Suggested Readings

1. John B. Liljedahl, Paul K Turnquist, David W Smith and MakotoHoki "Tradctor and Their Power Units" CBS Publisher, 2004.
2. Rodichev V and G Rodicheva, "Tractor and Automobiles" MIR Publication Moscow, 1984.
3. Kirpal Singh, "Automobile Engineering Vol-I" Standard Publisher Distributor, Delhi 13th Edition, 2012.
4. Joseph Heitner, "Automotive Mechanics: Principles and Practices" CBS Publishers 2006.
5. C.B. Richey, "Agricultural Engineering Handbook" McGraw Hill Inc. USA 1961.

AE-504 (DC) ENGINEERING PROPERTIES OF AGRICULTURAL PRODUCE

Contact Hour/ week	Credits
1 (Lecture)	1

Course Outcome: At the end of the course, the student will learn -

CO1: About different techniques of measurement of engineering properties and their importance in design of processing equipments.

Unit-I

Classification and importance of engineering properties of agricultural produce,physical properties such as shape, size, roundness, sphericity, volume, density, porosity, specific gravity, surface area of grains, fruits and vegetables.

Unit-II

Thermal properties such asheat capacity, specific heat, thermal conductivity, thermal diffusivity, co-efficient of thermal expansion.

Unit-III

Friction in agricultural materials; static friction, kinetic friction, rollingresistance, angle of internal friction, angle of repose, Flow of bulk granular materials, Aero dynamics of agricultural products, dragcoefficients, terminal velocity.

Unit-IV

Rheological properties; force, deformation, stress, strain, elastic, plastic and viscous behavior, Newtonian and Non-Newtonian liquid, Visco- elasticity, Newtonian and Non-Newtonian fluid, Pseudo-plastic, Dilatant, Thixotropic fluids.

Suggested Readings

1. Mohesin, N.N. 1980. Physical Properties of Plants & Animals, Gordon & Breach Science Publishers, New York.
2. Prentice, J.H. 1984. Measurement in Rheological Properties of Food Stuffs, Elsevier Applied Science Pub, Co. Inc. New York.
3. Rao, M.A. and Rizvi, S.H. 1995. Engineering Properties of Foods. Marcel Dekker Inc. New York.
4. Singhal O. P.and Samuel D. V. K. 2003. Engineering Properties of Biological Materials, Saroj Prakashan, New Delhi
5. Sahay, K.M. and Singh, K.K. 1994. Unit Operations of Agricultural Processing, Vikas, Publishing house Pvt. Ltd., New Delhi.

AE-505 (DC) RENEWABLE POWER SOURCES

Contact Hour/ week	Credits
2 (Lecture)	2

Course Outcome: At the end of the course, the student will be able to:
CO1: The course enables the student to outline the power generation potential from various renewable energy sources and performance evaluation of these devices.

Unit-I

Energy consumption pattern & energy resources in India. Renewable energy options, potential and utilization. Fundamentals of hydrogen and fuel cell technology.

Unit-II

Biogas technology and mechanisms, generation of power from biogas, Power generation from urban, municipal and industrial waste. Use of different commercial sized biogas plant.

Unit-III

Solar thermal and photovoltaic Systems for power generation. Central receiver (Chimney) and distributed type solar power plant, fundamentals of ocean thermal energy conversion technology, fundamentals of magneto hydro dynamic.

Unit-IV

Wind farms. Aero-generators. Wind power generation system. Power generation from biomass (gasification &Dendro thermal), Mini and microsmall hydel plants.

Suggested Readings

1. Garg H.P. 1990. Advances in Solar Energy Technology; D. Publishing Company, Tokyo.
2. Alan L: Farredbruch& R.H. Buse. 1983. Fundamentals of Solar Academic Press, London.
3. Bansal N.K., Kleemann M. &Meliss Michael. 1990. Renewable Energy Sources & Conversion Technology; Tata Mecgrow Publishing Company, New Delhi.
4. Rathore N. S., Kurchania A. K. & N.L. Panwar. 2007. Non Conventional Energy Sources, Himanshu Publications.
5. Mathur, A.N. & N.S. Rathore. 1992. Biogas Production Management & Utilization. Himanshu Publications, Udaipur.
6. Khandelwal, K.C. & S.S. Mahdi. 1990. Biogas Technology.
7. Rai, G.D. 2013. Non-Conventional Energy Sources, Khanna Publishers, Delhi.
8. Mathur A.N. & N.S. Rathore. Renewable Energy Sources Bohra Ganesh Publications, Udaipur.

AE-506 (DC) DRAINAGE ENGINEERING

Contact Hour/ week	Credits
1 (Lecture)	1

Course Outcome: At the end of the course, the student will be able to:
CO1: To train the students about the reclamation of the agricultural lands suffering from excessive water application and problematic soils

Unit-I

Water logging: Causes and impacts; drainage, objectives of drainage, familiarization with the drainage problems of the state; surface drainage coefficient, types of surface drainage, design of surface drains.

Unit-II

Sub-surface drainage: Purpose and benefits, investigations of design parameters-hydraulic conductivity, drainable porosity, water table;

Unit-III

Derivation of Hooghoudt's and Ernst's drain spacing equations: Design of subsurface drainage system; drainage materials, drainage pipes, drain envelope; layout, construction and installation of drains; drainage structures.

Unit-IV

Vertical drainage; bio-drainage; mole drains; salt balance, reclamation of saline and alkaline soils, leaching requirements, conjunctive use of fresh and saline water.

Suggested Readings

1. Bhattacharya AK and Michael AM. 2013. Land Drainage, Principles, Methods and Applications. Vikas Publication House, Noida (UP).
2. Ritzema H.P.1994 Drainage Principles and Applications, ILRI Publication 16, Second Edition (Completely Revised).
3. Michael AM. and Ojha TP. 2014. Principles of Agricultural Engineering Vol-II 5th Edition. Jain Brothers Publication, New Delhi.
4. Kadam U.S., Thokal R.T., Gorantiwar S.D. and Powar A.G. 2007. Agricultural Drainage-Principles and Practices, Westville Publishing House.
5. FAO Irrigation and Drainage Paper No. 6, 9, 15, 16, 28 and 38. Rome, Italy.

PROFESSIONAL ELECTIVE COURSE (PEC) – I (Department Elective I)

DE-501(DE) FOOD QUALITY AND CONTROL

Contact Hour/ week	Credits
2 (Lecture)	2

Course Outcome: At the end of the course, the student will be able to -
CO1: Understand concept of food quality, food safety measurements and various food standards.

Unit-I

Basics of food analysis, concept, objectives and need of food quality. Measurement of various properties and their relationship with food quality.

Unit-II

Sensory evaluation methods, panel selection methods, interpretation of sensory results. Instrumental method for testing quality, quality control and quality control tools.

Unit-III

Food adulteration and food safety. TQM and TQC, Food Safety Management Systems GAP, GHP, GMP and HACCP (Hazard analysis and critical control point), Sanitation in food industry (SSOP).

Unit-IV

Dried leafy vegetables viz. spinach, fenugreek, coriander leaves, etc, quality control: Food Laws and Regulations in India, FSSAI, Food grades and standards BIS, AGMARK, ISO 9000, 22000 Series. CAC (Codex Alimantarious Commission), PFA Act, FPO Act, AGMARK, ISO-2000,CAC Codex Alimanterious, commission), BIS.

Suggested Readings

1. Sohrab, Integrated ISO 9001 HACCP for Food Processing Industries, Allied Publishers Ltd, Mumbai
2. Krammer, A. and Twigg, B.A. Quality Control for the Food Industry, Volume 2, Applications. The AVI Publishing Company, Westport, Connecticut.
3. Ranganna, S., Hand book of Analysis and Quality Control for Fruits and Vegetable Products, Tata McGraw hill, New Delhi.

DE-502 (DE) MINOR IRRIGATION AND COMMAND AREA DEVELOPMENT

Contact Hour/ week	Credits
2 (Lecture)	2

Course Outcome: At the end of the course, the student will be able to:
CO1: To train the students for design of site specific liftirrigation system as peravailability of water andcommand area on community basis.

Unit-I

Factors affecting performance of irrigation projects; types of minor irrigation systems in India; lift irrigation systems: feasibility.

Unit-II

Type of pumping stations and their site selection, design of lift irrigation systems; tank Irrigation: grouping of tanks, storage capacity, supply works and sluices.

Unit-III

Command area development (CAD) programme: Components, need, scope, and development approaches, historical perspective, command area development authorities-functions and responsibilities; on farm development works, reclamation works.

Unit-IV

Use of remote sensing techniques for CAD works; water productivity: concepts and measures for enhancing water productivity; Farmers‟ participation in command area development.

Suggested Readings

1. Arora, K.R. 2001. Irrigation, Water Power and Water ResourcesEngineering. Standard Publishers Distributors, Delhi.
2. Garg S. K. 2014. Irrigation Engineering and Hydraulic Structures, Khanna Publishers New Delhi.
3. Michael A.M. 2012. Irrigation: Theory and Practice. Vikas Publishing VikasPubl.House New Delhi.
4. Sahasrabudhe SR. 2011. Irrigation Engineering and Hydraulic structures. SK Kataria& Sons Reprint 2015.

DE-503 (DE) WASTELAND DEVELOPMENT

Contact Hour/ week	Credits
2 (Lecture)	2

Course Outcome: At the end of the course, the student will be able to-
CO1: To train the students about the understanding of ravine rehabilitation, Afforestation - agro-horti-forestry-silvipasture development and land reclamation and rehabilitation.

Unit-I

Land degradation — concept, classification - arid, semiarid, humid and sub-humid regions, denuded range land and marginal lands. Wastelands - factors causing, classification and mapping of wastelands, planning of wastelands development - constraints, agro-climatic conditions, development options, contingency plans.

Unit-II

Conservation structures - gully stabilization, ravine rehabilitation, sand dune stabilization, water harvesting and recycling methods. Afforestation -
agro-horti-forestry-silvipasture methods, forage and fuel crops -socioeconomic constraints.

Unit-III

Shifting cultivation, optimal land use options. Wasteland development — hills, semi-arid, coastal areas, water scarce areas, reclamation of waterlogged and salt-affected lands. Mine spoils- impact, land degradation and reclamation and rehabilitation, slope stabilization and mine environment management.

Unit-IV

Micro-irrigation in wastelands development. Sustainable wasteland development - drought situations, socio-economic perspectives. Government policies. Participatory approach. Preparation of proposalfor wasteland development and benefit-cost analysis.

Suggested Readings

1. Abrol, I.P., and V.V. Dhruvanarayana. 1998. Technologies for Wasteland Development. ICAR, New Delhi.
2. Ambast, S.K., S.K. Gupta and Gurcharan Singh (Eds.) 2007. Agricultural Land Drainage - Reclamation of Waterlogged Saline Lands. Central Soil Salinity Research Institute, Karnal, Haryana.
3. Hridai Ram Yadav. 2013. Management of Wastelands. Concept Publishing Company. New Delhi.
4. Karthikeyan, C., K. Thangaraja, C. Cinthia Fernandez and K. Chandrakandon. 2009. Dryland Agriculture and Wasteland Management. Atlantic Publishers and Distributors Pvt. Ltd., New Delhi.
5. Rattan Lal and B.A. Stewart (Ed.). 2015. Soil Management of Smallholder Agriculture. Volume 21 of Advances in Soil Science. CRC Press, Taylor and Francis Group, Florida, USA.
6. Robert Malliva and Thomas Missimer. 2012. Arid Lands Water Evaluation and Management. Springer Heidelberg, New York.
7. Swaminathan, M.S. 2010. Science and Integrated Rural Development. Concept Publishing Company (P) Ltd., Delhi.
8. The Energy and Resources Institute. 2003. Looking Back to Think Ahead-Green India 2047. Growth with Resource Enhancement of Environment and Nature. New Delhi.
9. Virmani, S.M. (Ed.). 2010. Degraded and Wastelands of India: Status and Spatial Distribution. ICAR, New Delhi.

PROFESSIONAL ELECTIVE COURSE (PEC) – II (Department Elective II)

DE-504 (DE) FOOD PACKAGING TECHNOLOGY

Contact Hour/ week	Credits
2 (Lecture)	2

Course Outcome: At the end of the course, the student will be able to-
CO1: Acquaint with various food packaging materials, various aspects of packaging methods and technology.

Unit-I

Factors affecting shelf life of food material during storage, Packaging of foods, requirement, importance and scope, frame work of packaging strategy, environmental considerations, Packaging systems, types: flexible and rigid; retail and bulk; levels of packaging.

Unit-II

Different types of packaging materials, their key properties and applications, metal cans, plastic packaging, different types of polymers used in food packaging and their barrier properties. Manufacture of plastic packaging materials; glass containers, types of glass used in food packaging, manufacture of glass and glass containers, closures for glass containers. Paper and paper board packaging, modification ofbarrier properties and characteristics of paper/ boards.

Unit-III

Nutritional labeling on packages, CAP and MAP, shrink and cling packaging, vacuum and gas packaging; active packaging, factors affecting the choice of packaging materials, disposal and recycle ofpackaging waste, printing and labeling; lamination.

Unit-IV

Package testing, testing methods for flexible materials, rigid materials andsemi rigid materials; Tests for paper, glass containers, metal containers.

Suggested Readings

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

DE-505 (DE) MECHANICS OF TILLAGE &TRACTION

Contact Hour/ week	Credits
2 (Lecture)	2

Course Outcome: At the end of the course, the student will be able to:
CO1: Know Mechanics of soil cutting, Traction force, torque-slip relationship and traction aid for tractor and other traction machineries.

Unit-I

Introduction to mechanics of tillage tools, engineering properties of soil, design of tillage tools principles of soil cutting, design equation.

Unit-II

Introduction to traction mechanics, Measurement and characterization of terrain behaviour: stress-strain relationship, pressure sinkage relationship and cone penetrometer.

Unit-III

Motion resistance of a rigid and pneumatic wheel, Mechanics of towed, self propelled and driving wheel; Wheel slip, its measurement; Criteriaof performance of traction devices.

Unit-IV

Traction prediction approach: Mobility number & effect of mobility number on tractive effort, traction improvement, tyre construction: bias and radial, tyre testing, soil compaction.

Suggested Readings

1. W.R. Gill and Vanden Berg. (1968). Soil Dynamics in Tillage, Handbook No. 316, US Department of Agriculture, USA.
2. M.G. Bekker. (1956). Theory of land Locomotion, University of Michigan Press, USA.
3. M.G. Bekker. (1969). Off-Road Locomotion, University of Michigan Press USA.
4. M.G. Bekker. (1969). Introduction of Terrain Vehicle System, Michigan, USA.
5. J.Y. Wong. (1978). Theory of Ground Vehicle, John Willey & Sons, New York.

DE-506 (DE) AGRICULTURAL STRUCTURES AND ENVIRONMENTAL CONTROL

Contact Hour/ week	Credits
2 (Lecture)	2

Course Outcome: At the end of the course, the student will able to
CO1: Understand various aspects ofagricultural structures such as farm stead and dairy barn, environment control.

Unit-I

Planning and layout of farmstead, farm fencing, physiological responses of livestock, Environment conducive for the livestock and poultry.

Unit-II

Dairy barn design, site selection and layout of dairy barn, and poultry farm design, site selection and lay out of poultry farm.

Unit-III

Site selection and orientation of building in regard to sanitation, community sanitation system; sewage system - its design, design of septic tank for small family.

Unit-IV

Scope, importance and need for environmental control, renewable and non-renewable resources and their equitable use, concept of eco system, biodiversity of its conservation, environmental pollution and their control, solid waste management system.

Suggested Readings

1. Pandey, P.H. Principles and Practices of Agricultural Structures andEnvironmental Control, Kalyani Publishers, Ludhiana.
2. Ojha, T.P and Michael, A.M. Principles of Agricultural Engineering. Vol. I, Jain Brothers, Karol Bag, New Delhi.
3. Nathonson, J.A. Basic Environmental Technology, Prentice Hall of India, New Delhi.
4. Venugopal Rao, P. Text Book of Environmental Engineering, Prentice Hall of India, New Delhi.
5. Garg, S.K. Water Supply Engineering, Khanna Publishers, New Delhi-6.
6. Dutta, B.N. Estimating and Costing in Civil Engineering, Duttta & Co., Lucknow.
7. Khanna, P.N. Indian Practical Civil Engineer‟s Hand Book, Engineer‟s Publishers, New Delhi.
8. Sahay, K.M. and Singh, K.K. Unit Operations of Agricultural Processing, Vikas Publishing pvt. Ltd, Noida.
9. Banerjee, G.C. A Text Book of Animal Husbandry, Oxford IBH Publishing Co, New Delhi.

PRACTICAL & SESSIONAL

DE-507 (DC) FARM MACHINERY AND EQUIPMENT – I

Contact Hour/ week	Credits
2 (Lab)	1.5

Practicals

1. Introduction to various farm machines and visit to implement's shed.
2. Construction details, adjustments and working of M.B. plough.
3. Construction details, adjustments and working of disc plough.
4. Construction details, adjustments and working of disc harrow.
5. Construction details, adjustments and working of secondary tillage tools.
6. Field capacity and field efficiency measurement of tillage and planting equipment.
7. Draft & fuel consumption measurement of different implements.
8. Working of seed-cum-fertilizer drill and its calibration.
9. Working of planters.
10. Weeding equipments and their use.
11. Study of knapsack and foot sprayers.
12. Study of rotary duster.
13. Construction and working of rotavator.
14. Study of bulldozer.

DE-508 (DC) TRACTOR SYSTEMS AND CONTROLS

Contact Hour/ week	Credits
2 (Lab)	1.5

Practical

1. Study of brake systems: Drum and disc brakes, Mechanical and Hydraulic brakes
2. Introduction to transmission systems and components: study of different types of gear boxes and design problems on gear box.
3. Study on differential and final drive and planetary gears.
4. Study of clutch functioning and parts.
5. Appraisal of various controls in different makes tractors in relation to anthropometric measurements.
6. Determination of location of CG of a tractor.
7. Traction performance of a traction wheel.

DE-509 (DC) ENGINEERING PROPERTIES OF AGRICULTURAL PRODUCE

Contact Hour/ week	Credits
2 (Lab)	1

Practical

1. Determination of the shape and size of grains, fruits and vegetables.
2. Determination of bulk density and angle of repose of grains.
3. Determination of the particle density/true density and porosity of grains.
4. Finding the co-efficient of external and internal friction of different grains.
5. Determination of specific heat of some food grains.
6. Determination of hardness of food material.
7. Determination of viscosity of liquid foods.

DE-510 (DC) RENEWABLE POWER SOURCES

Contact Hour/ week	Credits
2 (Lab)	1

Practical

1. Performance evaluation of solar water heater.
2. Performance evaluation of solar cooker.
3. Characteristics of solar photovoltaic panel.
4. Performance evaluation of solar air heater/dryer.
5. Performance evaluation of biomass gasifier engine system (throatless & downdraft)
6. Performance evaluation of a fixed dome type biogas plant.
7. Performance evaluation of floating drum type biogas plant.
8. Estimation of calorific value of biogas & producer gas.
9. Testing of diesel engine operation using dual fuel and gas alone.

DE-511 (DC) DRAINAGE ENGINEERING

Contact Hour/ week	Credits
2 (Lab)	1

Practical

1. *In-situ* measurement of hydraulic conductivity by single auger hole.
2. *In-situ* measurement of hydraulic conductivity by inverse auger holemethod.
3. Estimation of drainage coefficients.
4. Installation of piezometer and observation wells.
5. Preparation of iso-bath and isobar maps.
6. Determination of drainable porosity.
7. Design of surface drainage systems.
8. Design of gravel envelop.
9. Design of subsurface drainage systems.
10. Determination of chemical properties of soil and water.
11. Study of drainage tiles and pipes.
12. Installation of sub-surface drainage system.
13. Cost analysis of surface drainage system.
14. Cost analysis of sub-surface drainage system.
15. Field visit to water logged area.

DE-513 (DE-501) (DC) FOOD QUALITY AND CONTROL

Contact Hour/ week	Credits
2 (Lab)	1

Practical

1. Examination of cereals & pulses from one of go-downs and market shops in relation to FPO and BIS specifications.
2. Detection of adulteration and examination of ghee for various standards of AGMARK & BIS standards.
3. Detection of adulteration and examination of spices for AGMARK and BIS standards.
4. Detection of adulteration and examination of milk and milk products for BIS standards.
5. Detection of adulteration and examination of fruit products such as jams, jellys, marmalades for FPO specification.
6. Visit to quality control laboratory.
7. Case study of statistical process control in food processing industry.
8. Study of sampling techniques from food processing establishments.
9. Visit to food processing laboratory and study of records and reports maintained by food processing laboratory.

DE-512 (DE-502) (DC) MINOR IRRIGATION AND COMMAND AREA DEVELOPMENT

Contact Hour/ week	Credits
2 (Lab)	1

Practical

1. Preparation of command area development layout plan;
2. Irrigation water requirement of crops;
3. Preparation of irrigation schedules;
4. Planning and layout of water conveyance system;
5. Design of surplus weir of tanks;
6. Determination of storage capacity of tanks;
7. Design of intake pipe and pump house.
8. Field visit to command area.

DE-512 (DE-503) (DC) WASTELAND DEVELOPMENT

Contact Hour/ week	Credits
2 (Lab)	1

Practical

1. Mapping and classification of wastelands.
2. Identification of factors causing wastelands.
3. Estimation of vegetation density and classification.
4. Planning and design of engineering measures for reclamation of wastelands.
5. Design and estimation of different soil and water conservation structures under arid conditions.
6. Design and estimation of different soil and water conservation structures under semiarid conditions.
7. Design and estimation of different soil and water conservation structures under humid conditions.
8. Planning and design of micro-irrigation in wasteland development.
9. Cost estimation of the above measures / structures.
10. Visit to wasteland development project sites.

DE-513 (DE-504) FOOD PACKAGING TECHNOLOGY

Contact Hour/ week	Credits
2 (Lab)	1

Practical

1. Identification of different types of packaging materials.
2. Determination of tensile/compressive strength of given material/package.
3. Vacuum packaging of agricultural produces.
4. Determination of tearing strength of paper board.
5. Measurement of thickness of packaging materials.
6. To perform grease-resistance test in plastic pouches.
7. Determination of bursting strength of packaging material.
8. Determination of water-vapour transmission rate.
9. Shrink wrapping of various horticultural produce.
10. Testing of chemical resistance of packaging materials.
11. Determination of drop test of food package and visit to relevant industries.

DE-513 (DE-504) MECHANICS OF TILLAGE &TRACTION

Contact Hour/ week	Credits
2 (Lab)	1

Practical

1. Measurement of static and dynamic soil parameters related to tillage.
2. Measurement of slip and sinkage under dry and wet soil conditions.
3. Measurement of load and fuel consumption for different farm operations.
4. Studies on tyres under different conditions.
5. Studies on compaction and number of operations.

DE-513 (DE-504) AGRICULTURAL STRUCTURES AND ENVIRONMENTAL CONTROL

Contact Hour/ week	Credits
2 (Lab)	1

Practical Practical

1. Instruments for measurements of environmental parameters.
2. Cooling load of a farm building e.g. poultry house.
3. Design and layout of a dairy farm.
4. Design and layout of a poultry house.
5. Design and layout of a sheep/goat house.
6. Design of a farm fencing system.
7. Design of ventilation system for dairy and poultry house.
8. Design of a feed/fodder storage structures.
9. Familiarization with local grain storage structures.
10. Design of grain storage structures.
11. Cost estimation of a farm building.

3RD YEAR – VI SEMESTER

AE 601 (DC) DESIGN OF STRUCTURES

Contact Hour/ week	Credits
2 (Lecture)	2

Course Outcome: At the end of the course, the student will be able to:
CO1: Analyze Singly and doubly reinforced beams, T- beams
CO2: Understand shear behavior and analyze one way & two way slabs
CO3: Design and analyze of RC Column
CO4: Analyze tension and compression member

(A) Reinforced cement concrete structures

Unit-I

Introduction: Grade of Concrete and Characteristics strength, permissible stress in concrete and steel reinforcement.
Singly Reinforced Beams: Fundamental assumptions, Equivalent areaof sections, Neutral axis and Moment of resistance. Balanced, Under- reinforced and Over-reinforced sections.Types of problems in singlyreinforced beams.
Doubly Reinforced Beam: Neutral axis, Moment of resistance. Typeof problems.
T-Beams: Dimensions, Neutral axis. Lever arm, Moment of resistance with or without web compression.Type of problems in T-Beams.

Unit-II

Shear: Shearstress in R. C. beams, Effect of shear, Reinforcement design for shear. Bond, anchorage, development length.Slabs spanning in one direction.*Two way slabs:* Supported on four edges with corners not held down and carrying U.D.L.

Unit-III

Axially loaded columns: Long and short columns. Types of columns.
Load carrying capacity, I. S. recommendations, Deign of columns with lateral and spiral reinforcement.

(B) **Steel structures**

Unit-IV

Introduction: Types of steels as a structural material, various grades of structural steel, properties and their permissible stresses. Various rolled steel sections and their properties.
Design of tension and compression member.
Note: The use of IS 456:2000, SP16, IS 800:2007 shall be allowedin the examination.

Suggested Readings

1. B.C. Punmia. (1992). Reinforced Concrete Structure, Vol.I, Standard Publishers & Distributors, Delhi.
2. Jain and Jaikrishna. (1992). Plane and Reinforced Cement Concrete, Nemi Chand Bros., Roorkee.
3. M.M. Malhotra. (1992). Design of Steel Structure, Jain Brothers, New Delhi.
4. Ram Chandra. (1992). Design of Steel Structures, standard Publishers & Distributors, New Delhi.

AE 602 (DC) FARM MACHINERY AND EQUIPMENT– II

Contact Hour/ week	Credits
2 (Lecture)	2

Course Outcome: At the end of the course, the student will be able to:
CO1: To identify the need of timely harvesting of crops in India.
CO2: Also equip the students with technical knowledge and skills required for the operation, maintenance and evaluation of harvesting, threshing and land preparation (heavy) machinery needed for agricultural farms.
CO3: To abreast the students with mathematical, experimental and computational skills for solving different field problems.
CO4: To develop skills in the students required to develop and modification of indigenous harvesting machines/methods asper the need of the area and farmers
CO5: Also to give a brief introductory idea of importance of testing of agricultural machines and tractors.

Unit-I

Principles and types of cutting mechanisms. Harvesting equipment, Mowers — types of mowers (reciprocating and rotary); cutter bar, mowers parts, construction operation and adjustments. Accelerating forces on reciprocating parts and numerical problems. Attachments to the cutter bar, trouble shooting, cutting pattern of reciprocating knife. VCR and its constructional. Simple numerical problems on mowers.

Unit-II

Forage Chopping and Handling: Types of field forage harvesters and choppers, part and construction, details of forage choppers, Attachments, maintenance, trouble shooting. Numerical problems onforage choppers. Introduction of Grain harvesting.

Unit-III

Types and different functional units of combine. Operation, adjustment and different losses. Numerical problems on losses. Introduction to straw combine. Principles of threshing and various types of threshers. Maize harvesting and shelling equipment, Introduction to plot combines and plot threshers.

Unit-IV

Root crop harvesting equipment – potato. Horticultural tools: hand tools and posthole digger. Testing procedure for thresher and combine by using BIS Test codes. Introduction to Laser land leveller.

Suggested Readings

1. Bainer, R. Barger, E.L. and R.A. Kepner. (1997). Principle of Farm Machinery. John Wiley & Sons, inc, New York.
2. A.C. Shrivastava. et al. Principle of Farm Machinery, ASAE publications.
3. H.P. Smith. (1977). Farm Power and Equipment, Tata Mc-Graw Hill Publishing Co. Ltd., New Delhi
4. FAO, Bulletin. (1977). Elements of Agricultural Machinery, volume II.
5. O.P. Singhal. Elements of Agricultural Engineering, Part I and II. SarojPrakashan, Allahbad.
6. Singh, S. Principles of Farm Machinery. DIPA, ICAR, KAB -I, New Delhi.
7. Singh, S. and Verma, S.R. Farm Machinery Maintenance and Management. DIPA, ICAR, KAB -I, New Delhi.

AE 603 (DC) SOIL AND WATER CONSERVATION ENGINEERING

Contact Hour/ week	Credits
2 (Lecture)	2

Course Outcome:

CO1: To have understanding about the degradation of productive soil globally and its effect thereon.

CO2: to know about the causes about water scarcity and their solution to fight against the evil effects through soiland water conservation technologies.

Unit-I

Soil erosion: Introduction, causes and types - geological and accelerated erosion, agents, factors affecting and effects of erosion. Water erosion - Mechanics and forms - splash, sheet, rill, gully, ravine and stream bank erosion. Gullies - Classification, stages of development.

Unit-II

Soil loss estimation: Universal soil loss equation (USLE) and modified USLE. Rainfall erosivity - estimation by KE>25 and EI_{30} methods. Soil erodibility - topography, crop management and conservation practice factors. Measurement of soil erosion - Runoff plots, soil samplers. Water erosion control measures - agronomical measures - contour farming, strip cropping, conservation tillage and mulching.

Unit-III

Engineering measures: Bunds and terraces. Bunds - contour and graded bunds - design and surplussing arrangements. Terraces - level and graded broad base terraces, bench terraces - planning, design and layout procedure, contour stonewall and trenching. Gully and ravine reclamation - principles of gully control - vegetative measures, temporary structures and diversion drains.

Unit-IV

Grassed waterways and design: Wind erosion- Factors affecting, mechanics, soil loss estimation and control measures - vegetative, mechanical measures, wind breaks and shelter belts and stabilization of sand dunes. Land capability classification. Rate of sedimentation, silt monitoring and storage loss in tanks.

Suggested Readings

1. Singh Gurmel, C. Venkataraman, G. Sastry and B.P. Joshi. 1996. Manual of Soil and Water Conservation Practices. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
2. Mahnot, S.C. 2014. Soil and Water Conservation and Watershed Management. International Books and Periodicals Supply Service, New Delhi.
3. Mal, B.C. 2014. Introduction to Soil and Water Conservation Engineering. 2014. Kalyani Publishers.
4. Michael, A.M. and T.P. Ojha. 2003. Principles of Agricultural Engineering. Volume II. 4th Edition, Jain Brothers, New Delhi.
5. Murthy, V.V.N. 2002. Land and Water Management Engineering. 4th Edition, Kalyani Publishers, New Delhi.
6. Norman Hudson. 1985. Soil Conservation. Cornell University Press, Ithaka, New York, USA.
7. Frevert, R.K., G.O. Schwab, T.W. Edminster and K.K. Barnes. 2009. Soil and Water Conservation Engineering, 4th Edition, John Wiley and Sons, New York.
8. Suresh, R. 2014. Soil and Water Conservation Engineering. Standard Publisher Distributors, New Delhi.

AE 604 (DC) WATERSHED PLANNING AND MANAGEMENT

Contact Hour/ week	Credits
1 (Lecture)	1

Course Outcome: At the end of the course, the student will be able to:
CO1: To acquaint the students about the preparation of the detail report of the problems and causes related to the water, land, vegetation and social aspects of specific area and their remedies through watershed planning and management.

Unit I

Watershed: Introduction and characteristics. Watershed development - problems and prospects, investigation, topographical survey, soil characteristics, vegetative cover, present land use practices and socio- economic factors.

Unit-II

Watershed management: Concept, objectives, factors affecting, watershed planning based on land capability classes, hydrologic data for watershed planning, watershed codification, delineation and prioritization of watersheds – sediment yield index.

Unit-III

Water budgeting in a watershed. Management measures - rainwater conservation technologies - in-*situ* and *ex-situ* storage, water harvesting and recycling. Dry farming techniques - inter-terrace and inter-bund landmanagement. Integrated watershed management - concept, components.

Unit-IV

Watershed programme - execution, follow-up practices, maintenance, monitoring and evaluation. Participatory watershed management - role of watershed associations, user groups and self-help groups. Planning and formulation of project proposal for watershed management programme including cost-benefit analysis.

Suggested Readings

1. Ghanshyam Das. 2008. Hydrology and Soil Conservation Engineering: Including Watershed Management. 2nd Edition, Prentice-Hall of India Learning Pvt. Ltd., New Delhi.
2. Katyal, J.C., R.P. Singh, Shriniwas Sharma, S.K. Das, M.V. Padmanabhan and P.K. Mishra. 1995. Field Manual on Watershed Management. CRIDA, Hyderabad.
3. Mahnot, S.C. 2014. Soil and Water Conservation and Watershed Management. International Books and Periodicals Supply Service. New Delhi.
4. Sharda, V.N., A.K. Sikka and G.P. Juyal. 2006. Participatory Integrated Watershed Management: A Field Manual. Central Soil and Water Conservation Research and Training Institute, Dehradun.
5. Singh, G.D. and T.C. Poonia. 2003. Fundamentals of Watershed Management Technology. Yash Publishing House, Bikaner.
6. Singh, P.K. 2000. Watershed Management: Design and Practices. E-media Publications, Udaipur.
7. Singh, R.V. 2000. Watershed Planning and Management. Yash Publishing House, Bikaner.
8. Tideman, E.M. 1999. Watershed Management: Guidelines for Indian Conditions. Omega Scientific Publishers, New Delhi.

AE 605 (DC) BIO-ENERGY SYSTEMS: DESIGN AND APPLICATIONS

Contact Hour/ week	Credits
2 (Lecture)	2

Course Outcome:

CO1: To provide fundamentals of utilization of crop residues and agro industrial waste for energy production through different conversion routes and to understanding the biofuels system, renewable feedstock and their production so that following the completion of this course, students will have the expertise to solve agro industrial, social, and environmental problems with appropriate techniques and tools.

Unit-I

Fermentation processes and its general requirements. An overview of aerobic and anaerobic fermentation processes and their industrial application. Heat transfer processes in anaerobic digestion systems, land fill gas technology and potential.

Unit-II

Biomass Production: Wastelands, classification and their use through energy plantation, selection of species, methods of field preparation and transplanting. Harvesting of biomass and coppicing characteristics. Biomass preparation techniques for harnessing (size reduction, densification and drying).

Unit-III

Thermo-chemical degradation. History of small gas producer engine system. Chemistry of gasification. Gas producer — type, operating principle. Gasifier fuels, properties, preparation, conditioning of producer gas. Application for shaft power generation, thermal application and economics.

Unit-IV

Trans-esterification for biodiesel production. A range of bio-hydrogen production routes. Environmental aspect of bio-energy, assessment of greenhouse gas mitigation potential.

Suggested Readings

1. British BioGen. 1997, Anaerobic digestion of farm and food processing practices- Good practice guidelines, London, available on www.britishbiogen.co.UK.
2. Butler, S. 2005. Renewable Energy Academy: Training wood energy professionals.
3. Centre for biomass energy. 1998. Straw for energy production; Technology- Environment-Ecology. Available: www.ens.dk.

AE 606 (DC) GROUNDWATER, WELLS AND PUMPS

Contact Hour/ week	Credits
2 (Lecture)	2

Course Outcome: At the end of the course, the student will be able to:
CO1: To enable the students to know about the ground water potential, its dynamic behaviour and exploration manual and mechanically.

Unit-I

Occurrence and movement of ground water; aquifer and its types; classification of wells, fully penetrating tubewells and open wells, familiarization of various types of bore wells; design of open wells;

Unit-II

Groundwater exploration techniques; methods of drilling of wells: percussion, rotary, reverse rotary; design of tubewell and gravel pack, installation of well screen, completion and development of well; groundwater hydraulics-determination of aquifer parameters by different method such as Theis, Jacob and Chow‟s, Theis recovery method.

Unit-III

Well interference, multiple well systems, estimation of ground water potential, quality of ground water; artificial groundwater recharge techniques; pumping systems: water lifting devices; different types of pumps, classification of pumps, component parts of centrifugal pumps, priming, pump selection, installation and trouble shooting.

Unit-IV

Well performance curves, effect of speed on capacity, head and power, effect of change of impeller dimensions on performance characteristics; hydraulic ram, propeller pumps, mixed flow pumps and their performancecharacteristics; deep well turbine pump and submersible pump.

Suggested Readings

1. Michael AM, Khepar SD. and SK Sondhi. 2008. Water Well and Pumps, 2nd Edition, Tata Mc-Graw Hill.
2. Todd David Keith and Larry W. Mays. 2004. Groundwater Hydrology, 3rd Edition, John Wiley & Sons, New York (International Book Distributing Company Lucknow).
3. Michael AM. and Ojha TP. 2014. Principles of Agricultural Engineering Vol-II, 5th Edition. Jain Brothers Publication, New Delhi.

PROFESSIONAL ELECTIVE COURSE (PEC) – III (Department Elective III)

DE-601 (DE) PROCESS EQUIPMENT DESIGN

Contact Hour/ week	Credits
2 (Lecture)	2

Course Outcome: At the end of the course, the student will able to
CO1: Understand various types of material available for fabrications of equipments, different types of heat exchanger and design of shell and tube heat exchanger.

Unit-I

Introduction on process equipment design, application of design engineering for processing equipments, design parameters and general design procedure, material specification, types of material for process equipments.

Unit-II

Moisture content determination, EMC models principle of drying, theory of diffusion, various drying rate periods falling rate and constant rate period of drying, critical moisture content.

Unit-III

Design of cleaners, design of tubular heat exchanger, classification of dryers and operation, heat transfer in grain drying, dryer performance, drying methods.

Unit-IV

Scope & importance of material handling devices, design consideration of different types of material handling devices such as belt, chain, screw conveyor, bucket elevator, pneumatic conveying, capacity and power requirement.

Suggested Readings

1. Mahajani, V. V. and Umarji, S. B., Process Equipment Design, Macmillan.
2. Geankoplis C.J. (2007) Transport Processes and Unit Operations, Prentice-Hall.
3. Rao, D. G. Fundamentals of Food Engineering, PHI Learning Pvt. Ltd, New Delhi.

DE-602 (DE) TRACTOR DESIGN AND TESTING

Contact Hour/ week	Credits
2 (Lecture)	2

Course Outcome: At the end of the course, the student will be able to:
CO1: Design parameters of tractor engine components and power transmission system. Stability during operation and different tests conducted on tractor.

Unit-I

Introduction to development of agricultural tractor. Study of parameters for balanced design of tractor for stability, weight distribution and hitch system.

Unit-II

Design of various engine components: Piston, cylinder and cylinder liner, connecting rod, crankshaft and valve.

Unit-III

Design of mechanical power transmission in agricultural tractors. Design of Ackerman Steering. Introduction of computer application to design of engine components, differential, final drive and axle power takeoff shaft.

Unit-IV

Design of seat and controls of an agricultural tractor. Tractor Testing as per BIS codes.

Suggested Readings

1. A. Kolchin and V. Dominov. (1984). Design of Automotive Engines. Mir Publications, Moscow.
2. B.J. Liljedahl, P.K. Turnquist, W.D. Singh and Hoki, Makato. (1989). Tractor and there Power Units, Fourth Edition, Avi Publication, New York.
3. C.V. Litchy. (1951). Internal Combustion Engines, McGraw Hill Pub., New York.
4. V.L. Maleev. (1951). Internal Combustion Engines, McGraw Hill Pub., New York.

DE-603 (DE) LANDSCAPE IRRIGATION DESIGN AND MANAGEMENT

Contact Hour/ week	Credits
2 (Lecture)	2

Course Outcome: At the end of the course, the student will be able to:
CO1: To train the students about the field specific for design of irrigation system, their proper operation, automation and the maintenance of the system.

Unit-I

Conventional method of landscape irrigation: Hose irrigation system, quick release coupling system and portable sprinkler with hose pipes.

Unit-II

Modern methods of landscape irrigation- pop-up sprinklers, spray pop- up sprinkler, shrub adopter, drip irrigation and bubblers; Merits and demerits of conventional and modern irrigation systems, types of landscapes and suitability of different irrigation methods.

Unit-III

Water requirement for different landscapes, Segments of landscape irrigation systems, Main components of modern landscape irrigation systems and their selection criteria; Types of pipes, pressure ratings, sizing and selection criteria.

Unit-IV

Automation system for landscape irrigation: Main components, types of controllers and their application, Design of modern landscape irrigation systems, operation and maintenance of landscape irrigation systems.

Practical

1. Study of irrigation equipments for landscapes;
2. Design and installation of irrigation system for landscape,
3. Determination of water requirement.
4. Determination of power requirement, pump selection.
5. Irrigation scheduling of landscapes,
6. Study of irrigation controllers and other equipments,
7. Use of AutoCAD in irrigation design: blocks & symbols, head layout, zoning and valves layout, pipe sizing, Pressure calculations etc.,
8. Visit to landscape irrigation system and its evaluation.

Suggested Readings

1. Michael A.M. 2012. Irrigation: Theory and Practice. Vikas Publishing Vikas Publ. House New Delhi.
2. Singh Neeraj Partap. 2010. Landscape Irrigation and Floriculture Terminology, Bangalore.
3. Smith Stepehen W. Landscape Irrigation and Management. Amazon. com.

PRACTICAL & SESSIONAL

AE-605 (DC) FARM MACHINERY AND EQUIPMENT– II

Contact Hour/ week	Credits
2 (Lab)	1

Practical

1. Familiarization with various farm machines related to harvesting, threshing and combine.
2. Study of cutter bar: constructional details, adjustments and working.
3. Study of vertical conveyor reaper: constructional details, adjustments and working.
4. Study of potato harvester: constructional details, adjustments and working.
5. Study of forage harvester: constructional details, adjustments and working.
6. Study of maize sheller: constructional details, materials and working.
7. Study of various types of threshers: constructional details, adjustments and working.
8. Study of combine harvester: constructional details, working and trouble shooting.
9. Study of straw combine.
10. Study of laser land leveller.
11. Study of post hole digger.

AE-606 (DC) TRACTOR AND FARM MACHINERY OPERATION AND MAINTENANCE

Contact Hour/ week	Credits
2 (Lab)	1

Practical

Course Outcome: At the end of the course, the student will be able to:

Firsthand experience in field operation and adjustmentsof various agricultural implements and equipmentsExposure to small scale farm machinery manufacturingunit.

1. Familiarization with different makes and models of agricultural tractors. Identification of functional systems including fuels system, cooling system, transmission system, steering and hydraulic systems.
2. Study of maintenance points to be checked before starting a tractor. Familiarization with controls on a tractor. Safety rules and precautions to be observed while driving a tractor.
3. Driving practice of tractor. Hitching & De-hitching of mounted and trail type implement to the tractor.
4. Practice of operating a tillage tool (mould-board plough/ disc plough) and their adjustment in the field. Study of field patterns while operating a tillage implement.
5. Introduction to tractor maintenance – precautionary and break-down maintenance.
6. Introduction to trouble shooting in tractors. Familiarization with tools for general and special maintenance. Introduction to scheduled maintenance after 10, 100, 300, 600, 900 and 1200 hours of operation.
7. Safety hints. Top end overhauling. Fuel saving tips. Preparing the tractor for storage.
8. Care and maintenance procedure of agricultural machinery during operation and off-season.
9. Replacement of furrow openers and change of blades of rotavators.
10. Maintenance of cutter bar in a reaper.
11. Adjustments in a thresher for different crops. Replacement of V- belts on implements.
12. Setting of agricultural machinery workshop.

AE-607 (DC) SOIL AND WATER CONSERVATION ENGINEERING

Contact Hour/ week	Credits
2 (Lab)	1

Practical

1. Study of different types and forms of water erosion.
2. Exercises on computation of rainfall erosivity index.
3. Computation of soil erodibility index in soil loss estimation.
4. Determination of length of slope (LS) and cropping practice (CP) factors for soil loss estimation by USLE and MUSLE.
5. Exercises on soil loss estimation/measuring techniques.
6. Study of rainfall simulator for erosion assessment.
7. Estimation of sediment rate using Coshocton wheel sampler and multi-slot devisor.
8. Determination of sediment concentration through oven dry method.
9. Design and layout of contour bunds.
10. Design and layout of graded bunds.
11. Design and layout of broad base terraces.
12. Design and layout of bench terraces. Design of vegetative waterways.
13. Exercises on rate of sedimentation and storage loss in tanks.
14. Computation of soil loss by wind erosion. Design of shelterbelts and wind breaks for wind erosion control.
15. Visit to soil erosion sites and watershed project areas for studying erosion control and water conservation measures.

AE-608 (DC) WATERSHED PLANNING AND MANAGEMENT

Contact Hour/ week	Credits
2 (Lab)	1

Practical

1. Exercises on delineation of watersheds using toposheets.
2. Exercises on PRA.
3. Surveying and preparation of watershed map.
4. Quantitative analysis of watershed characteristics and parameters.
5. Watershed investigations for planning and development.
6. Analysis of hydrologic data for planning watershed management.
7. Water budgeting of watersheds.
8. Prioritization of watersheds based on sediment yield index.
9. Study of functional requirement of watershed development structures.
10. Study of watershed management technologies.
11. Practice on softwares for analysis of hydrologic parameters of watershed.
12. Study of role of various functionaries in watershed development programmes.
13. Techno-economic viability analysis of watershed projects.
14. Visit to watershed development project areas.

AE-609 (DC) BIO-ENERGY SYSTEMS: DESIGN ANDAPPLICATIONS

Contact Hour/ week	Credits
2 (Lab)	1

Practical

1. Study of anaerobic fermentation system for industrial application.
2. Study of gasification for industrial process heat.
3. Study of biodiesel production unit.
4. Study of producer gas burner.
5. Study of biomass densification technique (briquetting, pelletization, and cubing).
6. Integral bio energy system for industrial application.

AE-610 (DC) GROUNDWATER, WELLS AND PUMPS

Contact Hour/ week	Credits
2 (Lab)	1

Practical

1. Verification of Darcy's Law;
2. Study of different drilling equipments;
3. Sieve analysis for gravel and well screens design;
4. Estimation of specific yield and specific retention;
5. Testing of well screen;
6. Estimation of aquifer parameters by Theis method,
7. Estimation of aquifer parameters by Coopers-Jacob method,
8. Estimation of aquifer parameters by Chow method;
9. Estimation of aquifer parameters by Theis Recovery method;
10. Well design under confined and unconfined conditions; well losses and well efficiency;
11. Estimating ground water balance;
12. Study of artificial ground water recharge structures;
13. Study of radial flow and mixed flow centrifugal pumps, multistage centrifugal pumps, turbine, propeller and other pumps;
14. Installation of centrifugal pump; testing of centrifugal pump and study of cavitations;
15. Study of hydraulic ram; study and testing of submersible pump.

AE-611 (DE-601) (DC) PROCESS EQUIPMENT DESIGN

Contact Hour/ week	Credits
2 (Lab)	1

Practical

1. Study of cleaners.
2. Study of milling equipments.
3. Study of tubular heat exchanger.
4. EMC models development
5. Design of belt conveyor, bucket elevator, screw conveyor.
6. Material of construction used in equipments.
7. Various methods of moisture content determination.
8. Determination of constant rate drying period.
9. Determination of falling rate drying period.
10. Performance evaluation of dryer.

AE-611 (DE-602) (DC) TRACTOR DESIGN AND TESTING

Contact Hour/ week	Credits
2 (Lab)	1

Practicals

1. Design problem of tractor clutch.
2. Design problem on spur gears.
3. Design problem of bevel gears.
4. Design problem of helical gears.
5. Design of gear box (synchromesh/constant mesh).
6. Selection of tractor tires – Problem solving.
7. Problem on design of governer.
8. Engine testing as per BIS code – various tests; Drawbar performance in the lab; PTO test and measure the tractor power in the lab/field.
9. Visit to tractor testing centre/industry.

AE-611 (DE-603) (DC) LANDSCAPE IRRIGATION DESIGN AND MANAGEMENT

Contact Hour/ week	Credits
2 (Lab)	1

Practical

1. Study of irrigation equipments for landscapes;
2. Design and installation of irrigation system for landscape,
3. Determination of water requirement.
4. Determination of power requirement, pump selection.
5. Irrigation scheduling of landscapes,
6. Study of irrigation controllers and other equipments,
7. Use of AutoCAD in irrigation design: blocks & symbols, head layout, zoning and valves layout, pipe sizing, Pressure calculations etc.,
8. Visit to landscape irrigation system and its evaluation.

4TH YEAR – VII SEMESTER

AE 701(DC) SOLAR PHOTOVOLTAIC TECHNOLOGY AND SYSTEMS

Contact Hour/ week	Credits
3 (Lecture)	2

Course Outcome: The course is designed to

CO1: Generate awareness on fundamentals of solar pv systems and basic know how about pv technology and power generation.

Unit-I

Solar PV Technology: Advantages, Limitations, Current Status of PV technology, SWOT analysis of PV technology. Types of Solar Cell, Wafer based Silicon Cell, Thin film amorphous silicon cell Thin Cadmium Telluride (CdTe) Cell, Copper Indium Gallium Selenide (CiGS) Cell, Thin film crystalline silicon solar cell.

Unit-II

Solar Photo Voltaic Module: Solar cell, solar module, solar array, series & parallel connections of cell, mismatch in cell, fill factor, effect of solar radiation and temperature on power output of module, I-V and power curve of module.

Unit-III

Balance of Solar PV system: Introduction to batteries, battery classification, lead acid battery, Nicked Cadmium battery, comparison of batteries, battery parameters, Charge controller: types of charge controller,function of charge controller, PWM type, MPPT type charge controller.

Unit-IV

Converters: DC to DC converter and DC to AC type converter. Application of Solar PV system. Solar home lighting system, solar lantern, solar fencing, solar street light, solar water pumping system, Roof top solar photovoltaic power plant and smart grid.

Suggested Readings

1. Rai GD. 1998. Non-conventional Sources of Energy. Khanna Pub.
2. Rathore N.S., Kurchania A.K., Panwar N.L. 2006. Renewable Energy: Theory & Practice, Himanshu Publications,.
3. Solanki C.S. 2011. Solar Photovoltaic: Fundamentals, Technologies and Applications, PHI Learning Private Ltd.
4. Meinel & Meinel. Applied Solar Energy.
5. Derrick, Francis and Bokalders, Solar Photo-voltaic Products.

PROFESSIONAL ELECTIVE COURSE (PEC) – IV (Department Elective IV)

DE 701(DE) REMOTE SENSING AND GIS APPLICATIONS

Contact Hour/ week	Credits
2 (Lecture)	2

Course Outcome: At the end of the course, the student will be able to:

CO1: To train students in use of various hardware and software in use of satellite data, GPS technology in developing GIS based out puts for resource mapping and planning studies.

Unit-I

Basic component of remote sensing (RS), advantages and limitations of RS, possible use of RS techniques in assessment and monitoring of land and water resources; electromagnetic spectrum, energy interactions in the atmosphere and with the Earth‟s surface; major atmospheric windows; principal applications of different wavelength regions; typical spectral reflectance curve for vegetation, soil and water; spectral signatures; different types of sensors and platforms; contrast ratio and possible causes of low contrast.

Unit-II

Aerial photography; types of aerial photographs, scale of aerial photographs, planning aerial photography- end lap and side lap; stereoscopic vision, requirements of stereoscopic photographs; air- photo interpretation- interpretation elements; photogrammetry- measurements on a single vertical aerial photograph, measurements on a stereo-pair- vertical measurements by the parallax method; ground control for aerial photography.

Unit-III

Satellite remote sensing, multispectral scanner- whiskbroom and push- broom scanner; different types of resolutions; analysis of digital data- image restoration; image enhancement; information extraction, image classification, unsupervised classification, supervised classification, important consideration in the identification of training areas, vegetation indices; microwave remote sensing. GI Sand basic components, different sources of spatial data, basic spatial entities, major components of spatial data.

Unit-IV

Basic classes of map projections and their properties, Methods of data input into GIS, Data editing, spatial data models and structures, Attribute data management, integrating data (map overlay) in GIS, Application of remote sensing and GIS for the management of land and water resources.

Suggested Readings

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

DE 702 (DE) PRECISION FARMING TECHNIQUES FOR PROTECTED CULTIVATION

Contact Hour/ week	Credits
2 (Lecture)	2

Course Outcome: The student will

CO1: Gain knowledge of need, design and construction of Greenhouse. The student will be able to demonstrate the abilities to operate greenhouse by having the knowledge of root media, instrumentation, fertilization, and other operating parameters.

Unit-I

Protected cultivation: Introduction, History, origin, development, National and International Scenario, components of green house, perspective, Types of green houses, polyhouses /shed nets, Plant environment interactions — principles of limiting factors, solar radiation and transpiration, greenhouse effect, light, temperature, relative humidity,carbon dioxide enrichment.

Unit II

Design and construction of green houses: Site selection, orientation, design, construction, design for ventilation requirement using exhaust fan system, selection of equipment, Greenhouse cooling system — necessity, methods — ventilation with roof and side ventilators, evaporative cooling, different shading material fogging, combined fogging and fan-pad cooling system, maintenance of cooling and ventilation systems, pad care etc. Greenhouse heating — necessity, components, methods.

Unit-III

Root media – types – soil and soil less media, composition, estimation, preparation and disinfection, bed preparation. Planting techniques in green house cultivation. Irrigation in greenhouse and net house – Water quality, types of irrigation system, components, installation and material requirement. Fogging system for greenhouses and net houses —introduction, benefits, design, installation and material requirement. Maintenance of irrigation and fogging systems.

Unit-IV

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

Suggested Readings

1. Salokhe V.M. and Ajay Kumar Sharma 2006. Greenhouse: Technology and applications. Agrotech Publishing Academy, Udaipur (Raj) ISBN No. 81-8321-057-0
2. Singh Brahma and Balraj Singh. 2014. Advances in protected cultivation, New India Publishing Company.
3. Sharma P. 2007. Precision Farming. Daya Publishing House New Delhi.

DE 703 (DE) FOOD PLANT DESIGN AND MANAGEMENT

Contact Hour/ week	Credits
2 (Lecture)	2

Course Outcome: At the end of the course, the student will learn
CO1: Various aspects of designand layout of food plant.

Unit-I

Food plant location, selection criteria, Selection of processes, plant capacity, Requirements of plant building and its components, Project design, flow diagrams, selection of equipment, process and controls.

Unit-II

Objectives and principles of food plant layout. Salient features of processing plants for cereals, horticultural and vegetable crops, milkand milk products.

Unit-III

Entrepreneurship development in food industry, New product development process, Government schemes and incentive for promotion of entrepreneurship.

Unit-IV

Govt. policy on small and medium scale food processing enterprise, export and import policies relevant to food processing sector, procedure of obtaining license and registration under FSSAI.

Suggested Reading

1. Hall, H.S. and Rosen, Y.S. (1963) Milk Plant Layout. FAO Publication, Rome.
2. López Antonio. Gómez. Food Plant Design.
3. RobbertsTheunis C.(2013) Food Plant Engineering Systems by CRC Press, Washington.
4. Maroulis Z B and Saravacos G D. (2007) Food Plant Economics. Taylor and Francis, LLC.
5. Mahajan M. (2014) Operations Research. DhanpatRai and Company Private Limited, Delhi.
6. Maroulis Z B. and Saravacos G.D. (2003) Food Process Design. Marcel Dekker, Inc,Cimarron Road, Monticello, New York 12701, USA.

OPEN ELECTIVE – I (University Elective -I)

UE-701 (UE) MANAGEMENT INFORMATION SYSTEM

Contact Hour/ week	Credits
3 (Lecture)	3

Course Outcome: At the end of the course, the student will be able to:
CO1: Identify and understand the nature of MIS in an organization
CO2: Understand and address the issue of information requirement,information collection and decidability
CO3: Identify types of MIS systems and ability to reduce complexityof systems.
CO4: Identify the master data in Personnel, Finance, Production,Material and Marketing.
CO5: Understand the steps for implementation of EnterpriseResource Planning (ERP).

Prerequisite: Good knowledge of the subject Database Managementsystems is desirable

Unit-I

Introduction: MIS concept, Definition, role & Impact of MIS, Process of management, organization structure & behaviour. **Basic of ManagementInformation System:** Decision Making, Information concepts.

Unit-II

System concepts & control, Types of system, handling system complexity, System development model. **Development of Management Information System:** Requirement and implementation of MIS, Choice ofinformation Technology for Management Information System.

Unit-III

Application of Management Information system: Application in manufacturing sector using for personal management, Financial management, Production Management, Material Management, Marketing Management Application in Service Sector.

Unit-IV

Enterprise Resource Planning (ERP): EMS, ERP, Benefits implementation, EMS & MIS. E-Business Security and control: Threat of accidents and Malfunctions, Threat of Computer Crime, Factors that increase the Risks, Methods of Minimizing Risk.

Suggested Readings

1. "Management Information System", W.S. Jawadekar, Tata McGraw Hill.
2. "Management Information", Loudon & Loudon, Pearson Education Asia.
3. "Information Systems", Steven Alter, Pearson Education Asia.

UE-702 (UE) PROJECT PLANNING AND CONTROL

Contact Hour/ week	Credits
3 (Lecture)	3

Course Outcome: At the end of the course, the student will be able to:
CO1: Understand and implement tools and techniques of Project planning and control also learn market demand and financial analysis, along with Social Cost Benefit Analysis.

Unit I

Identification of Investment Opportunities; Project ideas generation and screening, Phases in Project Management, Project feasibility study, Appraisal Criteria and Process: Methods of appraisal under certainty, uncertainty and risk;

Unit II

Market and Demand Analysis; Sources of information- primary and secondary; Demand forecasting and market planning; Technical Analysis: Materials and inputs; Production technology; Product mix; Plant location and layout; Selection of plant and equipment;

Unit III

Financial Analysis: Cost of project and means of financing; Major cost components; Planning capital structure; Financing schemes of financial institutions. Profitability and Financial Projections: Cost of production; Breakeven analysis; Projected balance sheet, profit and loss account and cash flow statement.

Unit IV

Social Cost Benefit Analysis: Meaning and methodology; L&M and UNIDO approach; SCBA in India. Project Review/control- Evaluation of project. PERT/CPM- Problem of time and cost overrun. Project implementation practices in India.

Suggested Readings

1. Bryce, MC: Industrial Development, McGraw Hill (Int. Ed), New York.
2. Chandra, Prasanna: Projects: Planning Analysis, Financing, Implementation, and Review Tata McGraw Hill, New Delhi
3. Patel, Bhavesh M, Project Management, Vikas publishing House pvt. Ltd., New Delhi
4. Chaudhary, S.: Project Management, Tata McGraw Hill, New Delhi
5. I.D.B.I: Manual of Industrial Project Analysis in Developing Countries.
6. O.E.C.D: (i) Manual for Preparation of Industrial Feasibility Studies, (ii) Guide to Practical Project Appraisal.
7. Pitale, R.L: Project Appraisal Techniques, Oxford and IBH.
8. Planning Commission: Manual for Preparation of Feasibility Report.
9. Timothy, D,R. and W.R Sewell: Project Appraisal and Review, Macmillan, India.
10. Chandra, P., Project Preparation, Appraisal and Implementation

UE-703 (UE) WASTE AND BY-PRODUCTS UTILIZATION

Contact Hour/ week	Credits
3 (Lecture)	3

Course Outcome:

CO1: The course is designed to generate awareness on recycling and energy recovery from different wastes and by-products from households, municipal or industrial sectors. It is useful in creating confidence on reduced dependence of fossil fuel based economy.

Unit-I

Types and formation of by-products and waste: Magnitude of waste generation in different food processing industries; Environmental performance of food industry to comply with ISO-14001 standards. Waste utilization in various industries, furnaces and boilers run on agricultural wastes and by-products. Biological and chemical oxygen demand from different food plant waste, other chemical impurities in industrial wastes like metallic ion, additives, and microbial load, etc.

Unit-II

Waste water 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 water, other ingredients like insecticide, pesticides and fungicides residues in waste water.

Pre-treatment of Waste Water: Single dwelling unit, a septic tank, Primary treatment: sedimentation, coagulation, flocculation and floatation, Secondary treatments:– trickling filters, oxidation ditches, activated sludge process, rotating biological contractors, lagoons, Advanced treatment process. Final Treatment Solid processing

Unit-III

Concept, scope and maintenance of Solid Waste treatment and disposal, Assessment, treatment and MSW management Land filling. Effluent treatment plants in Industries.

Unit-IV

Uses of different agricultural by-products from rice mill, sugarcane industry, oil mill, etc.

Bioconversion Technology: Organic manure, Vermi-composting, Biogas generation: design, construction, operation and management of institutional community and family size biogas plants, Biogas utilizationbriquetting of biomass as fuel, production of charcoal briquette, generation of electricity using surplus biomass, producer gas generation and utilization.

Suggested Readings

1. Markel, I.A. 1981. Managing Livestock Waste, AVI Publishing Co.
2. Pantastico, ECB. 1975. Post Harvest Physiology, Handling and utilization of Tropical and Sub-tropical fruits and vegetables, AVI Pub. Co.
3. Shewfelt, R.L. and Prussi, S.E. 1992. Post-Harvest Handling – A Systems approach, Academic Press Inc.
4. USDA. 1992. Agricultural Waste Management Field Hand book. USDA, Washington DC.
5. Weichmann J. 1987. Post Harvest Physiology of vegetables, Marcel and Dekker Verlag.
6. V.K. Joshi & S.K. Sharma. Food Processing Waste Management: Treatment & Utilization. New India Publishing Agency.
7. Vasso Oreopoulou and Winfried Russ (Edited). 2007. Utilization of By- products &Treatment of waste in the Food Industry. Springer Science & Business media, LLC 233 New York.
8. Prashar, Anupama and Bansal, Pratibha. 2007-08. Industrial Safety and Environment. S.K.

Kataria and sons, New Delhi
9. Garg, S K. 1998. Environmental Engineering (Vol. II) – Sewage Disposal and Air Pollution Engineering. Khanna Publishers, New Delhi
10. Bhatia, S.C. 2001. Environmental Pollution and Control in Chemical Process Industries. Khanna Publishers, New Delhi.

PRACTICAL & SESSIONAL
AE-704 (DC) SOLAR PHOTOVOLTAIC TECHNOLOGY AND SYSTEMS

Contact Hour/ week	Credits
2 (Lab)	2

Practical

1. To study of V-I characteristics of solar PV system
2. To demonstrate the I-V and p-V characteristics of PV module with varying tradition and temperature level
3. To demonstrate the I-V and p-V characteristics of series and parallel combinations of PV Module
4. To show the effect of variation in tilt angle on PV module power
5. To study smart grid technology and application.
6. To study manufacturing technique of solar array, different DC toDC and DC to AC converter.
7. To study domestic solar lighting system.
8. To study various solar module technologies.

4TH YEAR – VIII SEMESTER
OPEN ELECTIVE – II (University Elective -II)

UE-801 (UE) ENTREPRENEURSHIP AND BUSINESS MANAGEMENT

Contact Hour/ week	Credits
3 (Lecture)	3

Course Outcome: Upon completion of this course the students will be familiar with:
CO1: Selection and development of a small or medium business idea.
CO2: Make and Implement project proposals and reports to hunt for venture capital etc.
CO3: Market competition and innovation in products and processes.
CO4: Develop managerial skills to achieve goals, & Plan and implement projects applying management techniques.
CO5: Understand social responsibility as a modern management concept.

Unit - I

Entrepreneurship: Definition and Meaning; Characteristics of Entrepreneurship / Traits of an Entrepreneur; Functions of Entrepreneurship - Job Creation, Innovation, Inspiration, Economic Development; Types of Entrepreneurship, Entrepreneurship and Intrapreneurship, Entrepreneurship Strategy

The Business Plan: Creating and Starting the Venture: The Marketing Plan, The Financial Plan, Sources of Capital; Legal Issues for the Entrepreneur:Patents, Trademarks, Copyrights, Trade Secrets, Licensing, Product Safety and Liability, Insurance; Contracts, Advertising, Supply Chain Management, Retail & FDI

Proposals & risks: Project Report Preparation (Feasibility, Cost Estimation, CVP Analysis, Detailed Project Report, Concept of Risk and decision making, Risk Management-SWOT etc

Unit - II

Entrepreneurship and Innovation: The Innovation Concept, Importance of Innovation for Entrepreneurship, Source of Innovation for Opportunities, The Innovation Process, Product life cycle, new product development process, mortality curve, Creativity and innovation in product modification/ development

Entrepreneurship and Economic Development: Role of Entrepreneurship in Modern Economy, Managers Vs Entrepreneurship**:** Characteristic of Managers, Characteristic of Entrepreneurs, Similarities and differences between Managers and Entrepreneurs

Unit - III

Industry, Commerce and Business: Types of ownership in the organization- Definition, characteristics, Merits & Demerits; Single ownership, Partnership, Cooperative Organizations, Joint Stock Companies, Government owned, Differences between Management and Administration, Leadership Models.

Industry Size & Current schemes: Micro, Small, Medium- Industry; Registration Process, Current Promotional Schemes for new Enterprise

Unit - IV

Function of Management: Planning- Types of Planning - Strategic Plan, Tactical Plan and Operation Plan; Organizing-Definition and Meaning, Types of Organizing; Staffing- Definition and Meaning, Types of Staffing — Internal & External, The Basic Steps in the Staffing Process; Directing (Leading)-Definition and Meaning; Controlling- Definition and Meaning, Relationship between Planning and Controlling.

Social Responsibility: Social Obligation, Social Responsiveness andSocial Responsibility, Managerial Ethics

Suggested Readings

1. Entrepreneurship Development and Management, A. K. Singh, Jain Book Agency (JBA) publishes, New Delhi
2. Small Scale Industries and Entrepreneurship, Vasant Desai, Himalaya 2008
3. Industrial Engineering and Management, O.P.Khanna, Dhanpat Rai and Sons, Delhi
4. Industrial Management and Entrepreneurship, V. K. Sharma, Scientific Publishers, New Delhi.
5. Entrepreneurship, Roy Rajeev, Oxford Latest Edition.

UE-802 (UE) HUMAN ENGINEERING AND SAFETY

Contact Hour/ week	Credits
3 (Lecture)	3

Course Outcome: The student will have knowledge of

CO1: various human factors in system development, importance of anthropometry in utilization of work space, heat exchange process and performance and safety gadgets for different farm operations.

Unit-I

Human factors in system development: Concept of systems; basic processes in system development, performance reliability, human performance. Information input process, visual displays, major typesand use of displays, auditory and factual displays.

Unit-II

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.

Unit-IV

Dangerous machine (Regulation) act, Rehabilitation and compensation to accident victims, Safety gadgets for spraying, threshing, Chaff cutting and tractor & trailer operation etc.

Suggested Readings

1. Chapanis A. 1996. Human Factors in System Engineering. John Wiley & Sons, New York.
2. Dul J. and Weerdmeester B.1993. Ergonomics for Beginners. A Quick Reference Guide. Taylor and Francis, London.
3. Mathews J. and Knight A. A. 1971. Ergonomics in Agricultural Equipment Design. National Institute of Agricultural Engineering.
4. Astrand P. And and Rodahl K. 1977. Textbook of Work Physiology. Mc Hill Corporation, New York.
5. Mark S. Sanders and Ernest James McCormick. 1993. Human Factors in Engineering and Design. Mc Hill Corporation, New York.
6. Keegan J J, Radke AO. 1964. Designing vehicle seats for greater comfort. SAE Journal; 72:50~5.
7. Yadav R, Tewari V.K. 1998. Tractor operator workplace design-a review. Journal of Terra mechanics 35: 41-53.

UE-803 (UE) BIOENERGY ENGINEERING

Contact Hour/ week	Credits
3 (Lecture)	3

Course Outcome: Upon completion of this course the students will be familiar with:
CO1: Fundamentals of utilization of crop residues and agro industrial waste for energy production through different conversion routes and to understanding the biofuels system, renewable feedstock and their production so that following the completion of this course, students will have the expertise to solve agro industrial, social, and environmental problems with appropriate techniques and tools.

Unit-I

Fermentation processes and its general requirements. An overview of aerobic and anaerobic fermentation processes and their industrial application. Heat transfer processes in anaerobic digestion systems, land fill gas technology and potential.

Unit-II

Biomass Production: Wastelands, classification and their use through energy plantation, selection of species, methods of field preparation and transplanting. Harvesting of biomass and coppicing characteristics. Biomass preparation techniques for harnessing (size reduction, densification and drying).

Unit-III

Thermo-chemical degradation. History of small gas producer engine system. Chemistry of gasification. Gas producer — type, operating principle. Gasifier fuels, properties, preparation, conditioning of producer gas. Application for shaft power generation, thermal application and economics.

Unit-IV

Trans-esterification for biodiesel production. A range of bio-hydrogen production routes. Environmental aspect of bio-energy, assessment of greenhouse gas mitigation potential.

Suggested Readings

1. British Bio Gen. 1997, Anaerobic digestion of farm and food processing practices- Good practice guidelines, London, available on www.britishbiogen.co.UK.
2. Butler, S. 2005. Renewable Energy Academy: Training wood energy professionals.
3. Centre for biomass energy. 1998. Straw for energy production; Technology- Environment-Ecology. Available: www.ens.dk.