

Courses Related to
Farm Machinery and Power Engineering
for
Under Graduate Degree Programme

B.Tech. in Agricultural Engineering



Department of Farm Machinery and Power
Faculty of Agricultural Engineering
Bidhan Chandra Krishi Viswavidyalaya
Mohanpur, Nadia, West Bengal

Course Content for
B.Tech. in Agricultural Engineering

Semester – I		
Courses Code	Course Title	Credit Hours (L + P)
FMP-111	Engineering Drawing	0+2
FMP-112	Workshop Technology and Practice	0+2

Semester – III		
Courses Code	Course Title	Credit Hours (L + P)
FMP-231	Engineering Mechanics	3+0
FMP-232	Theory of Machines	2+0

Semester – IV		
Courses Code	Course Title	Credit Hours (L + P)
FMP-241	Farm Machinery & Equipment-I	2+1
FMP-242	Machine Design	2+0

Semester – V		
Courses Code	Course Title	Credit Hours (L + P)
FMP-351	Farm Machinery & Equipment-II	2+1
FMP-352	Tractor & Automotive Engines	2+1

Course Content for
B.Tech. in Agricultural Engineering

Semester – VI		
Courses Code	Course Title	Credit Hours (L + P)
FMP-361	Tractor Systems & Controls	2+1
FMP-362	Renewable Energy Sources	2+1

Semester – VII		
Courses Code	Course Title	Credit Hours (L + P)
FMP-471	Mechanics of Tillage and Traction	2+1
FMP-472	Bioenergy Systems: Design and Applications	2+1

Semester – III Courses offered in B.Sc. (Hons.) Ag.		
Courses Code	Course Title	Credit Hours (L + P)
AEG-209	Farm Machinery and Power	1+1

Semester – VI Courses offered in B.Sc. (Hons.) Ag.		
Courses Code	Course Title	Credit Hours (L + P)
AEG-359	Renewable Energy in Agriculture and Allied Sector	1+1

Semester – III Courses offered in B.Sc. (Hons.) Hort.		
Courses Code	Course Title	Credit Hours (L + P)
FMP(H)-206	Farm Power and Machinery for Horticulture	2+1

Syllabus for **B.Tech. in Agricultural Engineering**

Engineering

Drawing

(FMP-111)

2(0+2)

Objective

To enable the students to draw engineering drawings for some simple machines/ equipment.

Practical

Introduction to engineering drawing, practice of different layout drawings; Drawing instruments and their use; Introduction to lines, letterings, single stroke letters and gothic letters; Dimensioning, dimension line, extension line, arrow head, continuous and progressive dimensioning; Introduction of drawing scales, representative fraction; Practice on orthographic projections, reference planes, points and lines in space; Drawing for orthographic projection of points by first angle projection method; Third angle methods of projection; Projection of planes; Projections of solids: polyhedra, cylinder, cone; Projections of solids: prisms and pyramids; Development of surfaces of geometrical solids; Drawing the section of solids: cylinder, cone and sphere; Introduction to isometric scale, isometric view and isometric drawing; Isometric projection of geometrical solids; Preparation of working drawing from models and isometric views; Sectional drawing of simple machine parts; Nomenclature, thread profiles, multi start threads, left and right hand threads; Conventional representation of threads; Forms of screw threads like metric thread, Whitworth thread; Square thread: acme thread, knuckle thread, buttress thread; Square headed and hexagonal nuts and bolts; Different types of lock nuts, studs, machine screws, cap screws and wood screws; Processes for producing leak proof joints; Drawing of different types of rivet heads and riveted joints and foundation bolts; Drawing of stud screws, set screws, butt, hexagonal and square; Drawing of keys: taper, rank taper, hollow saddle etc.; Symbols for different types of welded joints.

Suggested Readings

1. Bhatt, N. D. 2010. Elementary Engineering Drawing. Charotar Publishing House Pvt. Ltd., Anand.
2. Bhatt, N. D. and Panchal, V. M. 2013. Machine Drawing. Charotar Publishing House Pvt. Ltd., Anand.
3. Narayana, K. L. and Kanniah, P. 2010. Machine Drawing. Scitech Publications (India) Pvt. Ltd, Chennai.

Workshop Technology and Practice (FMP-112)

2

(0+2)

Objective

To expose the students to basic manufacturing processes involved for production of different machine elements and to facilitate hands-on experience of using these machines.

Practical

Introduction about different shops in the workshop; Safety and precautions to be taken in the workshop; Study of different tools used for fitting and different fitting operations; Study of

various measuring instruments used for fitting; Exercise in fitting: sawing, filing and right angle fitting of MS flat; Working with complex fitting jobs: operations of drilling, reaming, and threading and with tap dies; Preparation of a paper weight; Study of various carpentry tools, types of wood and their characteristics and working with carpentry tools; Preparation of simple joints in carpentry: cross half lap joint or T-half joint, Mortise and Tenon joint in carpentry; Preparation of dovetail joint in carpentry; Study of welding, types of welding, oxyacetylene gas welding, types of flames, welding techniques and equipment used for gas welding, working with welding equipment; Working with electric arc welding; Equipment and tools, safety and precautions taken in arc welding; Preparation of Butt joint and lap joint with ARC welding; Preparation of Lap and butt joints using gas welding; Working on a lathe machine and study of different tools used in lathe machine; Exercise on simple turning, step turning in lathe machine; Preparation of job on taper turning, drilling, knurling and threading in lathe machine; Working with different machines in machine shop such as shaper, milling machine, etc. and with different tools used in machine shop; Exercise on bending, shaping etc.; Exercise on Drawing, Punching, Riveting; Making different types of sheet metal joints using G.I. sheets; Practice job on shaper; changing a round MS rod into square section with a shaper;

Exercise on a milling machine such as making a slot, gear tooth forming and indexing.

Suggested Readings

1. Chapman W A J. 2018. *Workshop Technology* (Vol. I and II). Arnold Publishers (India) Pvt. Ltd., AB/9, Safdarjung Enclave, New Delhi.
2. Hajra Choudhury S K, Roy N, Hajra Choudhury A K. 2017. *Elements of Workshop Technology* (Vol. I and II). Media Promoters and Publishers Pvt. Ltd, Mumbai.
3. Khurmi R S and Gupta J K. 2018. *A Text Book of Workshop Technology*. S. Chand & Company Ltd, New Delhi.
4. Raghuwansi B S. 2016. *A Course in Workshop Technology* (Vol. I and II). Dhanpat Rai and Sons, 1682, Nai Sarak, New Delhi.

Engineering Mechanics (FMP-231)

3

(2+1)

Objective

To make the students acquainted with the principles of engineering mechanics and the calculation of different stresses to be helpful for design of engineering structures

Theory

Basic concepts of engineering mechanics, statics, dynamics, kinetics, scalar quantities, vector quantities, systems of units. Composition and resolution of forces, analytical method, graphical method. Laws of forces, moments and their application, levers, parallel forces and couples. Equilibrium of forces, free body diagrams. Centre of gravity (CG) of simple geometrical figures, CG by moments, plane figures, axis of references, CG of symmetric sections, unsymmetrical sections, solid bodies and cut sections. Moment of inertia: Methods of finding out M.I., methods of integration, M.I. of different sections, Theorem of perpendicular axes, parallel axes, M.I. of composite sections and cut sections. Frictional forces, static friction, dynamic friction, limiting friction, normal reaction, angle of friction, coefficient of friction, laws of friction, equilibrium of a body lying in horizontal and inclined planes, ladder friction; wedge friction, screw friction, screw jack. Analysis of simple framed structures, methods of sections, force table, methods of joints, hinged joints, roller support, vertical and inclined loads. Simple stresses and strain, Hooke's law, Poisson's ratio, modulus

of elasticity, Strain related problems. Shear force and bending moment, fundamentals of shear force and bending moment, SFD and BMD of cantilever and simply supported and overhanging beams, point of contra-flexure. Torsion of circular shaft, torsional effect, hoop stress, power transmitted by a shaft. Principal stresses and strain, analysis of plane and complex stress, principal planes and principal stresses, Mohr's circle, finding out principal stresses, different analysis.

Practical

Problems on composition and resolution of forces; Study the moments of a force; Problems related to resultant of a concurrent-coplanar force system; Problems related to non-concurrent coplanar force system; Systems of couples in space; Problems related to centroids of composite areas; Problems on Moment of Inertia, radius of gyration of composite areas; Analysis of equilibrium of concurrent coplanar and non-concurrent coplanar force system; Problems involved with frictions; Analysis of simple trusses by methods of joints and methods of sections; Analysis of simple trusses by graphical method; Problems on simple stress and strains; Problems on shear and bending moment diagrams. Problems on stresses on beams. Problems on torsion of the shafts; Analysis of plane and complex stresses.

Suggested Readings

1. Bansal, R. K. 2005. *A Text Book of Engineering Mechanics*. Laxmi Publishers, New Delhi.
2. Khurmi, R. S. 2006. *Strength of Materials*. S. Chand Publishing.
3. Khurmi, R. S. 2018. *A Text Book of Engineering Mechanics*. S. Chand Publishing.
4. Prasad, I. B. 2004. *Applied Mechanics and Strength of Materials*. Khanna Publishers, New Delhi.
5. Prasad, I. B. 2004. *Applied Mechanics*. Khanna Publishers, New Delhi.
6. Sundarajan, V. 2002. *Engineering Mechanics and Dynamics*. Tata McGraw Hill Publishing Co. Ltd, New Delhi.
7. Timoshenko, S. and Young, D. H. 2003. *Engineering Mechanics*. McGraw Hill Book Co., New Delhi.

Theory of Machines (FMP-232)

2

(2+0)

Objective

1. To enable the students to analyse the relative motion between various parts of machine and forces which act on them.
2. To apply the theories in designing the various parts of the machine.

Theory

Simple mechanism: 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; Velocity mechanism: determination of velocity and acceleration using graphical (instantaneous centres) method. Types of gears, law of gearing, velocity of sliding between two teeth in mesh; Involute and cycloidal profile for gear teeth; Spur gear, nomenclature; Introduction to helical, spiral, bevel and worm gear; Simple, compound, reverted, and epicyclic trains; determining velocity ratio by tabular method. Turning moment diagrams, coefficient of fluctuation of speed and energy, weight of flywheel, flywheel applications. Belt drives: Types of drives, belt materials, length of belt, transmitted power, velocity ratio, belt size for flat and V belts; effect of centrifugal tension, creep and slip on power transmission;

chain drives, classification of chain drive, terms used in chain drive. Types of friction, laws of dry friction; friction of pivots and collars; single disc, multiple disc, and cone clutches, rolling friction; Types of governors, constructional details and analysis of Watt, Porter, Proell governors, effect of friction, controlling force curves. sensitiveness, stability, hunting, isochronism, power and effort of a governor. Static and dynamic balancing, balancing of rotating masses in one and different planes.

Suggested Readings

1. Ballaney, P. L. 2016. *A Text Book of Theory of Machines*. Khanna Publishers, New Delhi.
2. Bansal, R. K. 2009. *A Text Book of Theory of Machines*. Laxmi Publications (P) Ltd., New Delhi.
3. Khurmi, R. S. and Gupta, J. K. 2010. *A Text Book of Theory of Machines*. Euresia Publishing House (P) Ltd, New Delhi.
4. Ratan, S. S. 2010. *A Text Book of Theory of Machines*. Tata McGraw Hill Publishing Company Ltd, New Delhi.

Farm Machinery & Equipment- I (FMP-241)

3 (2+1)

Objective

To make the students acquainted with the basic construction and operational features of different farm machineries used in operations such as seed-bed preparation, sowing, planting and transplanting, etc., and their economics of operation.

Theory

Introduction to farm mechanization; Classification of farm machines; Unit operations in crop production; Identification and selection of machines for various operations on the farm. Materials used in construction of farm machines; Heat treatment processes and their use in farm machines; Properties of materials used for critical and functional components of agricultural machines; Different types of steels and alloys for agricultural applications; Identification of heat treatment processes specially for the agricultural machinery components.

Seed-bed preparation and its classification; Land reclamation and earth moving equipment; Machines used for primary tillage, secondary tillage, rotary tillage, deep tillage and minimum tillage, viz. mould-board plough, disc plough, chisel plough, sub-soiler, harrows, puddler, cultivators, identification of their major functional components; Attachments with tillage machinery; Hitching systems and controls. Calculation of field capacities and field efficiency; Draft of tillage tools and calculations for power requirement for the tillage machines; Calculation for economics of machinery usage; Comparison of ownership with hiring of machines. Sowing, planting and transplanting equipment, viz. seed drills, no-till drills, strip-till drills, different types of planters, bed-planters; Planting equipment for crops like sugarcane, potato; Furrow openers and metering systems in drills and planters; Calibration of seed-drills/ planters; Adjustments during operation. Testing and Evaluation of tillage and sowing equipment and their test codes.

Practical

Familiarization with different farm implements and tools; Study of hitching systems; Study on draft measurement; Study of different problems on machinery management.; Study of primary tillage machinery- types, construction, operation, adjustments and calculations of power and draft requirements; Study of secondary tillage machinery- types, construction, operation, adjustments and calculations of power and draft requirements; Study of different types of puddlers and determination of puddling index in the field; Study of sowing and

planting equipment- construction, types, calculation for calibration and adjustments; Study of seed drill and its calibration; Study of different types of metering mechanisms used in seed drills and planters; Study of paddy transplanters; Study of various pre-germinated paddy seeder; Study of vegetable transplanters; Identification of materials of construction in agricultural machinery and study of material properties; Testing and Evaluation of tillage and sowing equipment; Visit to a site to observe field operations of paddy transplanters; Visit to an implement manufacturing unit.

Suggested Readings

1. Jain, S. C. and Phillips, G. 2003. *Farm Machinery - An Approach*. Standard Publishers and Distributors.
2. Kepner, R. A., Bainer, R. and Barger, E. L. 2005. *Principles of Farm Machinery*. CBS Publishers and Distributors.
3. Lal, Radhey and Datta, A. C. 1978. *Agricultural Engineering through worked out examples*. Saroj Prakashan, Allahabad.

Machine Design (FMP-242)

2

(2+0)

Objective

To make the students acquainted with design considerations for various machine components so as to enable them to take up the work of new design.

Theory

Phases of design, design considerations; Common engineering materials and their mechanical properties; Types of loads and stresses, theories of failure, factor of safety, selection of allowable stress, stress concentration, elementary fatigue and creep aspects; Design of shafts under torsion and combined bending and torsion; Design of keys; Design of muff, sleeve, and rigid flange couplings; Cotter joints, design of socket and spigot cotter joint; knuckle joint; Design of welded subjected to static loads; Design of helical and leaf springs; Design of threaded fasteners subjected to direct static loads, bolted joints loaded in shear and bolted joints subjected to eccentric loading; Design of flat belt and V-belt drives and pulleys; Design of gears; Selection of anti-friction bearings.

Suggested Readings

1. Bhandari, V. B. 2007. *Introduction to Machine Design*. Tata Mc. Graw Hill Publishing House. New Delhi.
2. Jain, R. K. 2013. *Machine Design*. Khanna Publishers, 2-B Nath Market, Nai Sarak, New Delhi.
3. Khurmi, R. S. and Gupta, J. K. 2014. *A Text Book of Machine Design*. S. Chand & Company Ltd., New Delhi.
4. Sharma, P. C. and Agarwal, D. K. 2010. *Machine Design*. S. K. Kataria & Sons, New Delhi.

Farm Machinery and Equipment II (FMP-351)

3

(2+1)

Objective

To make the students acquainted with the basic construction and operational features, and economics of operation of different farm machineries used in operations such as weeding, harvesting, etc., including operations done by combines, etc.

Theory

Plant protection equipment: Different types of sprayers and dusters; Classification of sprayers and sprays; Types of nozzles; Calculations for calibration of sprayers and chemical application rates; Introduction to interculture equipment; Weeders- different types of manual and powered weeders; Functional requirements of weeders and main components; Different types of fertilizer application methods and equipment. Harvesting of crops: Harvesting methods, harvesting terminology; Mowers– types, constructional details, working and adjustments; Shear type harvesting devices- cutter bar, inertia forces, counter balancing, terminology, cutting pattern; Reapers, binders and windrowers- principle of operation and constructional details; Hay conditioning, importance, methods of hay conditioning, and calculation of moisture content of hay. Threshing: manual and mechanical systems; Types of threshing drums and their applications; Types of threshers- tangential and axial, constructional details and cleaning systems; Factors affecting thresher performance; Grain combines- combine terminology and features, classification of grain combines, study of material flow in combines; Computation of combine losses; Combine troubles and troubleshooting; Chaff cutters- working principle, constructional features and capacity calculations; Straw combines- working principle and constructional details. Root crop diggers: Principles of operation, functional components, blade adjustment and approach angle, calculation of material handled; Potato and groundnut diggers; Cotton harvesting cotton harvesting mechanisms, cotton pickers and strippers; Maize harvesting combines; Vegetables and fruit harvesting equipment and tools. Testing and Evaluation of intercultural, plant protection and harvesting machinery and their test codes.

Practical

Familiarization with plant protection and interculture equipment; Study of sprayer types, functional components, calibration; Study of dusters- types and functional components; Calculations for chemical application rates; Study of nozzle types and spread pattern using patternator; Familiarization with manual and powered weeding equipment and identification of functional components; Study of fertilizer application equipment including manure spreaders and fertilizer broadcasters; Study of various types of mowers, reaper, reaper binder; Study of functional components of mowers and reapers; Study of threshing systems, cleaning systems in threshers, calculations of losses in threshers; Study of functional units of grain combines and their types, calculations for grain losses in a combine; Study of root crop diggers and familiarization with the functional units and attachments; Study of the working of cotton and maize harvesters; Study of different vegetable and fruit harvesters; Testing and evaluation of intercultural, plant protection and harvesting machinery; Visit to field showing operations various machines; Visit to implement manufacturing unit.

Suggested Readings

1. Jain, S. C. and Phillips, G. 2003. *Farm Machinery - An Approach*. Standard Publishers and Distributors.
2. Kepner, R. A., Bainer, R. and Barger, E. L. 2005. *Principles of Farm Machinery*. CBS Publishers and Distributors.
3. Lal Radhey and Datta, A. C. 1978. *Agricultural Engineering through Worked Out Examples*. Saroj Prakashan, Allahabad.
4. Nakra, C. P. 2003. *Farm Machines and Equipment*. Dhanpat Rai and Publishing Co.

5. Smith, H. P. and Wilkes, L. H. 2011. *Farm Machinery and Equipment*. McGraw Hill Publication, New York.
6. Srivastav, A. K., Goering, C. E. and Rohrbach, R. P. 2005. *Engineering Principles of Agricultural Machines*. ASAE. St. Joseph, Mich.
7. Srivastava, A. C. 1991. *Elements of Farm Machinery*. Oxford and IBH Publication.
8. Srivastava, T. K. 2007. *A work Book on Practical Farm Machinery*. Vol. I and II. Saroj Prakashan, Allahabad
9. Suresh, R. and Kumar, S. 2018. *Farm Power and Machinery Engineering*. Standard Publishers.

Tractor & Automotive Engines (FMP-352)

3 (2+1)

Objective

To make the students acquainted with the working principles of different systems of internal combustion engines and tractor.

Theory

Sources of farm power: conventional and non-conventional energy sources; Classification of tractors and IC engines. Review of thermodynamic principles of IC (CI and SI) engines and deviation from ideal cycle; General energy equation and heat balance sheet; Derivation of thermal efficiency of Otto cycle, Diesel cycle and Dual cycle; Mechanical, thermal and volumetric efficiencies. Study of engine components their construction, operating principles and functions; Engine strokes and comparison of 2-stroke and 4-stroke engine cycles and CI and SI engines; Engine valve systems, valve mechanism, valve timing diagram, valve clearance adjustment; Cam profile, valve lift and valve opening area. Inlet and exhaust systems; Importance of air cleaning system; Types of air cleaners and performance characteristics of various air cleaners; Fuel supply system, types of fuels, properties of fuels, calculation of air-fuel ratio. Different tests on fuel for SI and CI engines; Detonation and knocking in IC engines;

Carburetion system, carburetors and their main functional components; Fuel injection system injection pump, their types, working principles; Fuel injector nozzles- types and working principles. Engine governing- need of governors, governor types and governor characteristics; Lubrication system- need, types, functional components; Lubricants- physical properties, additives and their application. Engine cooling system- need, cooling methods and main functional components; Need and types of thermostat valves; Additives in the coolant; Radiator efficiency. Ignition system of SI engines; Electrical system including battery, starting motor, battery charging, cut-out, etc.; Comparison of dynamo and alternator; Basics of engine testing.

Practical

Study of different systems of CI engines; Study of engine parts and functions, working principles, etc.; Study of valve systems construction and adjustments; Determination of physical properties of oil and fuel; Study of air cleaning system; fuel supply system of SI engine; Study of diesel injection system and timing; Study of cooling system, and fan performance, thermostat and radiator performance evaluation; Study of part load efficiencies and governing; Study of lubricating system and adjustments; Study of starting and electrical system; Study of ignition system; Study of tractor engine heat balance and engine performance curves; Study of dynamo; Visit to a nozzle calibration unit; Visit to engine manufacturer/ assembler/ spare parts agency.

Suggested Readings

1. Ganesan, V. 1999. *Internal Combustion Engines*. Mc Graw Hill, New Delhi.

2. Goering, C. E. and Hansen, A. C. 2004. *Engine and Tractor Power*. ASAE. St Joseph, Michigan.
3. Heitner, J. 2004. *Automotive Mechanics: Principles and Practices*. CBS Publishers.
4. Liljedahl, J. B., Turnquist, P. K., Smith, D. W. and Hoki, M. 1989. *Tractors and Their Power Units*. Van Nostrand Reinhold, New York.
5. Mathur, M. L. and Sharma, R. P. 1996. *A course in Internal Combustion Engines*. Dhanpat Rai and Sons, New Delhi.
6. Rodichev, V. and Rodicheva, G. 1984. *Tractors and Automobiles*. Mir Publishers, Moscow.
7. Singh, K. 2020. *Automobile Engineering*. Vol II. Standard Publishers and Distributors.

Tractor Systems & Controls (FMP-361)

3 (2+1)

Objective

1. To make the students acquainted with different systems in a tractor, such as the transmission, brake, steering and hydraulic systems.
2. To understand the ergonomical and safety considerations in tractor.

Theory

Transmission system- need of the system in a tractor, types, major functional systems; Clutch- need, types, functional requirements, construction and principle of operation; Single plate, multi-plate, centrifugal and dual clutch systems; Gear box- principle of operation, gear box types, functional requirements, and calculation for speed ratio; Differential system- need, functional components, construction, calculation for speed reduction; Final drive; Brake system- types, principle of operation, construction, calculation for braking torque; Steering system- requirements, steering geometry characteristics, functional components, calculation for turning radius; Ackerman steering; Steering systems in track type tractors; Hydraulic system- principle of operation, types, main functional components, functional requirements. hydraulic system adjustments and ADDC; Tractor power outlets- PTO standards, types and functional requirements. Traction- traction terminology, theoretical calculation of shear force and rolling resistance of traction device; Wheels and tyres- solid tyres and pneumatic tyres, tyre construction and tyre specifications; Traction aids; Tractor mechanics- forces acting on the tractor, determination of CG of a tractor, importance and determination of moment of inertia of a tractor, tractor static equilibrium, tractor stability especially at turns; Maximum drawbar pull and its determination; Tractor as a spring-mass system; Ergonomic considerations and operational safety; Tractor testing; Engine test codes.

Practical

Study of basic transmission systems and components; Study of clutch functioning, parts and design problem on clutch system; Study of different types of gear box, calculation of speed ratios, design problems on gear box; Study on differential, final drive and planetary gears; Study of brake systems and some design problems; Study of geometry and adjustments of tractor steering; Study of hydraulic systems in a tractor, hydraulic trainer and design problems; Study of various controls in different makes of tractors in relation to anthropometric measurements; Determination of CG and moment of inertia of a tractor; Study of traction performance of a traction wheel; Study of power transmission system of tractor; Study of hitching system of tractor with various matching implements; Study on safety requirements of tractor during operation; Study of tractor testing; Visit to tractor dealers' outlet/ tractor manufacturers.

Suggested Readings

1. Barger, E. L., Liljedahl, J. B. and McKibben, E. C. 1967. *Tractor and their Power Units*. Wiley Eastern.
2. BIS Test codes for tractor.
3. Giri, N. K. 2013. *Automobile Mechanics (SI Units)*. Khanna Publishers, Delhi.
4. Jain, S. C. and Rai, C. R. 2013. *Farm Tractor, Maintenance and Repair*. Standard Publisher and Distributers, Delhi.
5. Singh, K. 2020. *Automobile Engineering*. Standard Publisher and Distributers, Delhi.
6. Srivastav, A. K., Goering, C. E. and Rohrbach, R. P. 2005. *Engineering Principles of Agricultural Machines*. ASAE. St. Joseph, Michigan.

Renewable Energy Sources (FMP-362)

3

(2+1)

Objective

To make the students acquainted with the different renewable energy sources and to enable them to analyse and select the appropriate technology to meet the energy demand in different types of agricultural operations.

Theory

Different sources of renewable energy: Concepts and limitations of different renewable energy sources (RES) as solar, wind, geothermal, biomass, ocean energy sources; Criteria for assessing the potential of RES; Comparison of renewable energy sources with non-renewable sources. Solar energy: Energy available from sun, solar radiation data, solar energy conversion into heat through flat plate and concentrating collectors, different solar thermal devices, principle of natural and forced convection solar drying system; Solar photo voltaics-basics and applications, p-n junctions; Solar cells, PV systems, stand alone, grid connected solar power station; Calculation of energy through photovoltaic power generation and cost economics. Wind energy: Energy availability, general formula, lift and drag; Basics of wind energy conversion, effect of density, frequency variances, angle of attack, wind speed, types of windmill rotors, determination of torque coefficient, induction type generators; Working principle of wind power plant; Wind farms, aero-generators, wind power generation system. Biogas: Basics of anaerobic digestion, types and constructional details of biogas plants, biogas generation and its properties, factors affecting biogas generation and usages, design considerations, advantages and disadvantages of biogas spent slurry; Generation of power from biogas; Design and use of different commercial biogas plants. Power generation from urban, municipal and industrial waste; Ocean thermal and electric power generation, wave and tidal power; Power generation from biomass (gasification and Dendrothermal); Mini and micro hydel plants; Fuel cells and its associated parameters.

Practical

Study of solar thermal devices like solar cookers; Study of solar water heating system; Study of natural convection solar dryer; Study of forced convection solar dryer; Study of solar desalination unit; Study of solar greenhouse for agriculture production; Study of cost economics of solar thermal devices including solar panels; Study of solar photovoltaic system and study of characteristics of solar photovoltaic panel; Study of evaluation of solar air heater/dryer; Study of biogas plants and its components; Performance evaluation of a fixed dome type biogas plant; Performance evaluation of floating drum type biogas plant; Study of biomass gasifiers; Study of cost economics of biogas system; Visit to a windmill plant.

Suggested Readings

1. Basu, P. 2018. *Biomass Gasification and Pyrolysis Practical Design and Theory*. Academic Press.
2. Deublein, D. and Steinhauser, A. 2008. *Biogas from Waste and Renewable Resources*. WILEYVCH Verlag GmbH & Co. KGaA, Weinheim.
3. Duffie, J. A. and Beckman, W. A. 2013. *Solar Engineering of Thermal Process*. John Wiley and Sons.
4. Julian Chen, C. 2011. *Physics of Solar Energy*. John Wiley & Sons, Inc.
5. Khan, B. H. 2006. *Non-Conventional Energy Resources*. The McGraw Hill Publishers.
6. Knothe, G., Gerpen, J. V. and Krahl, J. (Eds). 2010. *The Biodiesel Handbook*. AOCS Press.
7. Patel, M. R. 2005. *Wind and Solar Power Systems*. CRC Press, Bota Racon.
8. Rai, G. D. 2013. *Non-Conventional Energy Sources*. Khanna Publishers, New Delhi.
9. Rai, G. D. 2020. *Solar Energy Utilization*. Khanna Publishers, New Delhi.
10. Reed, T. B. and Das, A. 1988. *Handbook of Biomass Downdraft Gassifier Engine Systems*. SERI, USA.
11. Ryszard, Petela. 2010. *Engineering Thermodynamics of Thermal Radiation for Solar Power Utilization*. The McGraw-Hill Companies.
12. Stefan, C. W. and Krauter. 2008. *Solar Electric Power Generation – Photovoltaic Energy Systems*. Springer.

Mechanics of Tillage and Traction (FMP-471)

3

(2+1)

Objective

To enable the students to

1. Know various engineering properties of soil and to understand the effect of these properties on the performance of tillage tools
2. Know the application of dimensional analysis on soil dynamics and traction
3. Understand the effect of soil compaction on crop growth
4. Know the use of GIS in soil dynamics

Theory

Introduction to mechanics of tillage tools, engineering properties of soil, principles and concepts, stress strain relationship; Design of tillage tools, principles of soil cutting, design equation, force analysis; Application of dimensional analysis in soil dynamics and traction prediction equation. Introduction to traction and mechanics, off-road traction and mobility, traction model, traction improvement, tyres-functions, size, lug geometry and their effects, tyre selection and testing; Soil compaction and plant growth and variability; Application of GIS in soil dynamics.

Practical

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

Suggested Readings

1. Gill and Vandenberg. 1968. *Soil Dynamics in Tillage and Traction*. Agricultural Research

Service, USDA, Govt. Printing Press, Washington, D.C.

2. Liljedahl, J. B., Turnquist, P. K., Smith, D. W. and Hoki, M. 2004. *Tractors and their Power Units*. CBS Publishers

3. Macmillan R H. 2002. *The Mechanics of Tractor-Implement Performance*. International Development Technologies Centre, University of Melbourne.

4. Terzaghi K and Peck R B and Mesri G. 1996. *Soil Mechanics in Engineering Practices*. John Wiley & Sons.

Bioenergy Systems: Design and Applications (FMP-472)

3

(2+1)

Objective

To make the students acquainted with the different biomass sources, and the different thermochemical and biochemical processes for bioenergy and fuel production.

Theory

Biomass sources and characteristics; Fermentation processes and its general requirements; Aerobic and anaerobic fermentation processes and their industrial applications; Heat transfer processes in anaerobic digestion systems. 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). Bio-energy- properties of biomass and conversion technologies, pyrolysis of biomass to produce solid, liquid and gaseous fuels; Biomass gasification, types of gasifiers, various types of biomass cook stoves for rural energy needs; Thermo-chemical degradation; History of small gas producer engine system; Chemistry of gasification; Producer gas- type, operating principle; Gasifier fuels, properties, preparation, conditioning of producer gas; Applications, shaft power generation, thermal application and economics; Trans-esterification for biodiesel production and application in CI engines; production process, properties and application of ethanol; Bio-hydrogen production routes. Environmental aspect of bio-energy; Assessment of greenhouse gas mitigation potential; Cost economics of bio-energy systems.

Practical

Study of anaerobic fermentation system for industrial application; Study of gasification for industrial process heat; Study of biodiesel production unit; Study of ethanol production unit; Study of biomass densification technique (briquetting, pelletization, and cubing); Study of integral bio energy system for industrial application; Study of bio energy efficiency in industry and commercial buildings; Study of energy efficiency in building, study of Brayton, Striling and Rankine cycles; Study of Biomass gasifiers; Study of biomass improved cook-stoves; Estimation of calorific value of biogas and producer gas; Testing of diesel engine operation using dual fuels and gas alone; Performance evaluation of biomass gasifier engine system (throat less and downdraft); Study on producer gas- types, application, shaft power generation, thermal application and economics; Study of cost economics of biofuel.

Suggested Readings

1. Basu, P. 2018. *Biomass Gasification, Pyrolysis and Torrefaction*. Academic Press.

2. Butler, S. 2005. *Renewable Energy Academy: Training Wood Energy Professionals*.

3. Knothe, G., Gerpen, J. V. and Krahl, J. (Eds). 2010. *The Biodiesel Handbook*. AOCS Press.

4. Rai, G. D. 2013. *Non-Conventional Energy Sources*. Khanna Publishers, New Delhi.

5. Reed, T. B. and Das, A. 1988. *Handbook of Biomass Downdraft Gasifier Engine Systems*. SERI.

*****Courses offered in B.Sc. (Hons.) Ag.*****

Farm Machinery and Power (AEG-209)

2(1+1)

Objectives

To enable the students to understand the need of farm power, basic principles and parts of IC engine, different tillage, sowing, intercultural, plant protection equipment, working principles of threshers, harvesting of field and horticultural crops.

Theory

Status of Farm Power in India; Sources of Farm Power, I.C. engines, working principles of I C

engines; comparison of two stroke and four stroke cycle engines, Study of different components of I.C. engine, I.C. engine terminology and solved problems; Familiarization with different systems of I.C. engines: Air cleaning, cooling, lubrication, fuel supply and hydraulic control system of a tractor; Familiarization with Power transmission system : clutch; gear box, differential and final drive of a tractor; Tractor types; Cost analysis of tractor power and attached implement; Criteria for selection of tractor and machine implements. Familiarization with Primary and Secondary Tillage implement; Implement for hill agriculture; implement for intercultural operations; Familiarization with sowing and planting equipment; calibration of a seed drill and solved examples; Familiarization with Plant Protection equipment; Familiarization with harvesting and threshing equipment.

Practical

Study of different components of I.C. engine. To study air cleaning and cooling system of engine; Familiarization with clutch, transmission, differential and final drive of a tractor; Familiarization with lubrication and fuel supply system of engine; Familiarization with brake, steering, hydraulic control system of engine; Learning of tractor driving; Familiarization with operation of power tiller; Implements for hill agriculture; Familiarization with different types of primary and secondary tillage implements: mould plough, disc plough and disc harrow; Familiarization with seed-cum-fertilizer drills their seed metering mechanism and calibration, planters and trans planter; Familiarization with different types of sprayers and dusters; Familiarization with different inter-cultivation equipment; Familiarization with harvesting and threshing machinery; Calculation of power requirement for different implements.

Suggested readings

1. Jagdiswar Sahay – Elements of Agricultural Engineering
2. Jain, S.C. and C.R. Rai-Farm Tractor and maintenance and repair. Standard Publishers, 1705-B, Naisarak. Delhi- 110006
3. Ojha, T.P. and A.M. Michael, A.M. Principles of Agricultural Engineering. Vol.I. Jain brothers, 16/893, East Park Road, Karol Bagh, New Delhi -110005
4. Surendra Singh- Farm machinery –Principles and applications, ICAR, New Delhi

Renewable energy in Agriculture and Allied Sector (AEG-359)

2

(1+1)

Objectives

1. To study the different renewable energy sources and its' conversion technologies
2. To acquire a practical knowledge on design, installation, maintenance of potential renewable energy sources of the country
3. To study the classification of energy sources-contribution of non-conventional energy sources in agriculture sector
4. To familiarization with biomass utilization for size-reduction, production of bio alcohol, bio diesel and bio-oil production and its application
5. To Familiarization with design, types, maintenance of biogas plants and gasifier
6. To study a solar energy, its collection, conversion methods and applications
7. To study a wind energy and its application.

Theory

Classification of energy sources, contribution of these sources in agricultural sector, Familiarization with biomass utilization for biofuel production and their application. Familiarization with production of biogas and producer gas and modifications of IC engines for usage. Production of bioalcohol, biodiesel and bio-oil production and their utilization as bioenergy resource. Introduction of solar energy, collection and their application, Familiarization with solar energy gadgets: solar cooker, solar water heater; application of solar energy: solar drying, solar pond, solar distillation, solar photovoltaic system: solar lighting system, solar lantern, solar fencing and solar pumping system and their application, introduction of wind energy and their application.

Practical

1. Availability and uses of non-conventional energy in agriculture sector
2. Bio fuel production from biomass and its application
3. Constructional details of different biogas plants (Deena bandu and KVIC), gas production, design aspects and and maintenance
4. Study of different types of gasifiers, running of gasifiers and and production of producer gas
5. Study and and constructional details of different solar gadgets like solar dryer, grain dryers
6. Study of constructional details of solar cookers
7. Study of constructional details of solar water heating systems
8. Study of solar photovoltaic system and and observing various factors (light intensity, direction) influencing efficiency of the photo-voltaic systems
9. Study of solar water pumps, solar fencing
10. Visit to solar photovoltaic farm
11. Visit to biogas-based power generation farm

Suggested readings

1. Chakravarthy, A. and Amalendu Chakraverty, 1989, Biotechnology and Other Alternative Technologies for Unitization of Biomass-Agricultural wastes. Ist Edition, Oxford and IBH Publishers, New Delhi.
2. Oja, T.P and Micheal, A.M., Principles of Agricultural Engineering, Vol-1, Jain brothers, New Delhi
3. Rai, G.D. 2004, Non-conventional Energy Sources, Kanna Publishers, New Delhi
4. Rajput, R.K. 2012. Non-conventional Energy sources, S. Chand Publishers
5. Rathore, N.S., Mathur, A.N, and Kothari, S., Alternative sources of Energy, ICAR Publiation

6. Veeresh Kumargoud, Tulsidas T.N., Eshwarappa. H., 2007. Biogas Technology, regional biogas development and training centre, UAS, GKVK, Bengaluru.
7. http://www.fao.org/biomass_briquetting

*****Courses offered in B.Sc. (Hons.) Hort.*****

Farm Power and Machinery for Horticulture (FMP(H)-206)

3 (2+1)

Objectives:

To acquaint students of the tools available at his disposal for doing the work in horticulture (mechanical power source: engines/ tractors; machines and tools for harvesting the horticultural produce: tillage equipment, planting equipment, plant care equipment).

Theory

Basic concepts of various forms of energy; Tractors, power tillers and their types and uses
Introduction about IC Engines: Basic principles of operation of compression, ignition and spark

ignition engines; two stroke and four stroke engines; Crank system, valve system, fuel supply system, cooling and lubrication systems; power transmission systems; broad understanding of performance and efficiency. Tillage: objectives, method of ploughing. Primary tillage implements: construction and function of improved indigenous ploughs, mould board ploughs, disc and rotary ploughs, offset rotavators. Secondary tillage implements construction and function of cultivators, harrows, levellers, ridgers and bund formers. Adjustments affecting performance in tillage equipment. Calculation of bite length of rotavator. Post-hole digger. Introduction about planting and transplanting equipment: potato planters, small seed planter, nursery sowing machinery, vegetable transplanters, plastic mulch and drip laying machinery. Introduction about intercultural machinery. Sprayers: Types, working principle, manual and tractor operated, gun-type and boom type. Special purpose sprayers: aeroblast sprayers, electrostatic sprayers, sprayer calibration and nozzle spacing. Safety features and safe use, shrub cutters, pick positioner; grafting, pruning and training tools and equipment; sweep, rotary weeders, tractor operated pruners. Crop harvesting equipment: potato diggers, fruit-pluckers, seed extraction machine.

Practical

Calculation on force, power and energy. IC engines – showing the components of dismantled engines. Familiarization with engine systems Primary and secondary tillage implements: hitching, adjustments and operations. Operation of post hole digger. Operation of planting and transplanting machinery. Operation of vegetable transplanter, plastic mulch and drip laying machinery. Operation of Inter-culture equipment including offset rotavator in orchard; calibration of plant protection equipment, calculation of dilution ratio and operation; operation of power weeder, shrub cutter. Operation of crop harvesting equipment and seed extraction machine. Operation of shrub cutters, fruit-pluckers, pick positioner.

Suggested readings

1. Sahay Jagdishwar. Elements of Agricultural Engineering.
2. Kepner R A, Bainer R and Barger E L. Principles of Farm Machinery.
3. Michael A M and Ojha T P. Principles of Agricultural Engineering.
4. Culpin C. Farm Machinery.
5. Rodichev V and Rodicheva G. Tractors and Automobiles.