

**R16 SYLLABUS  
FOR  
AGRICULTURAL ENGINEERING**

**For**

**SECOND YEAR ONLY**

*(Applicable for batches admitted from 2016-2017)*



**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA**

**KAKINADA - 533 003, Andhra Pradesh, India**

## FLUID MECHANICS AND OPEN CHANNEL HYDRAULICS

**Objective:** To enable the students to design efficient water conveyance systems like canals, channels and pipes from places of origin to delivery points by acquiring knowledge on the principles of mechanics of fluids, water measurement and regulation and open channel hydraulic principles.

### Unit – I:

Fluids-definitions-classification-properties, dimensions. Fluid pressure–introduction– Measurement of fluid pressure–peizometer tube manometry–types of manometers. Mechanical gauges-Bourdon’s tube pressure gauge-Diaphragm pressure gauge–Dead weight pressure gauge. Fluid Static force on submerged surfaces–Total force on horizontal, vertical and inclined surfaces. Center of pressure of an inclined immersed surface-Centre of pressure of a composite section. Pressure on a curved surface and its applications. Kinematics of fluid flow– introduction – continuity of fluid flow – Types of flow lines.

### Unit –II:

Boundary layer theory- Thickness of Boundary layer, Thickness of Boundary layer in a laminar flow, Thickness of Boundary layer in a turbulent flow, Prandtl’s Experiment of Boundary Layer separation. Dynamics of fluid flow – Various forms of energy in fluid flow, frictional loss, general equation. Bernoulli’s theorem, Euler’s equation of motion. Practical applications of Bernoulli’s theorem, Venturimeter, pitot tube, Orifice meter.

### Unit – III:

Buoyancy of flotation – metacentric height. Flow through orifices (Measurement of Discharge) – Types of orifices, Jet of water, vena contracta, Hydraulic coefficients, Experimental Method for Hydraulic Coefficients, Discharge through a rectangular orifice. Flow through Orifices (Measurement of Time) – Time of Emptying a square, rectangular or circular tank through an orifice at its bottom, time of emptying a hemispherical tank through an orifice at its bottom. Time of emptying a circular horizontal tank through an orifice at its bottom. Time of emptying a tank of variable cross-section through an orifice. Flow through Mouthpieces – Types of Mouthpieces – Loss of Head of a liquid flowing in a pipe, Discharge through a Mouthpiece. Flow over Notches- Types of notches, Discharge over a Rectangular Notch, Triangular Notch, Stepped Notch. Time of emptying a tank over a Rectangular Notch, Triangular Notch. Flow over weirs – Types of weirs, Discharge over a weir, Francis’s formula for Discharge over a Rectangular weir (Effect of End Contractions), Bazin’s formula for Discharge over a rectangular weir, velocity of approach, Determination of Velocity of Approach.

### Unit – IV:

Flow through simple pipes – Loss of head in pipes, Darcy’s formula for loss of Head in pipes, Chezy’s formula for loss of head in pipes. Transmission of power through pipes, Time of emptying a tank through a long pipe, Time of flow from one tank into another through a long pipe. Flow through compound pipes – Discharge through a compound pipe (Pipes in series)-Discharge through pipes in parallel, Equivalent size of a pipe, Discharge through branched pipes from one reservoir to another.

### Unit – V

Dimensional analysis and similitude – Rayleigh’s method & Buckingham’s pi theorem. Types of similarities, Dimensional analysis, dimensionless numbers, introduction to fluid machinery. Open channel hydraulics- classification of open channel and definitions. Chezy’s formula for discharge through an open channel.

### Unit – VI:

Bazin’s formula for discharge through open channel, Numerical Problems on design through open channel, Kutter’s formula for discharge, Problems on design. Manning’s formula for discharge through an open channel. Channels of most economical cross sections – Conditions for maximum discharge through a channel of rectangular section, trapezoidal section, circular section. Specific energy concept-Specific energy of a flowing fluid, specific energy diagram, critical depth, Type of flows, critical velocity. Velocity and Pressure profiles in open channels. Hydraulic jump, Types of Hydraulic Jumps, Depth of Hydraulic Jump, Loss of Head due to Hydraulic Jump.

**TEXT BOOKS:**

1. Hydraulics and Fluid Mechanics, Modi P M and Seth S. M. 1973. Standard Book House, Delhi.
2. Open Channel Hydraulics, Chow V T, 1983, McGraw Hill Book Co., New Delhi.

**REFERENCES:**

1. A Text book of Hydraulics, Fluid Mechanics and Hydraulic Machines, Khurmi, R. S. 1970. S. Chand & Company Ltd., New Delhi.

## RENEWABLE ENERGY SOURCES

### UNIT – I

**PRINCIPLES OF SOLAR RADIATION:** Role and potential of new and renewable source, the solar energy option, Environmental impact of solar power, physics of the sun, the solar constant, extraterrestrial and terrestrial solar radiation, solar radiation on tilted surface, instruments for measuring solar radiation and sun shine, solar radiation data. Flat plate and concentrating collectors, classification of concentrating collectors, orientation and thermal analysis, advanced collectors.

### UNIT-II

**SOLAR ENERGY STORAGE AND APPLICATIONS:** Different methods, Sensible, latent heat and stratified storage, solar ponds. Solar Applications- solar heating/cooling technique, solar distillation and drying, photovoltaic energy conversion. Wind Energy Sources and potentials, horizontal and vertical axis windmills, performance characteristics, Betz criteria.

### UNIT-III

**BIO-MASS:** Principles of Bio-Conversion, Anaerobic/aerobic digestion, types of Bio-gas digesters, gas yield, combustion characteristics of bio-gas, utilization for cooking, I.C.Engine operation and economic aspects.

### UNIT-IV

**GEOTHERMAL ENERGY:** Resources, types of wells, methods of harnessing the energy, potential in India.

### UNIT-V

**OCEAN ENERGY:** OTEC, Principles utilization, setting of OTEC plants, thermodynamic cycles. Tidal and wave energy: Potential and conversion techniques, mini-hydel power plants, and their economics.

### UNIT-VI

**DIRECT ENERGY CONVERSION:** Need for DEC, Carnot cycle, limitations, principles of DEC. Thermo-electric generators, seebeck, peltier and Joule-Thomson effects, Figure of merit, materials, applications, MHD generators, principles, dissociation and ionization, hall effect, magnetic flux, MHD accelerator, MHD Engine, power generation systems, electron gas dynamic conversion, economic aspects. Fuel cells, principles, faraday's law's, thermodynamic aspects, selection of fuels and operating conditions.

### TEXT BOOKS:

1. Renewable energy resources/ Tiwari and Ghosal/ Narosa.
2. Non-Conventional Energy Sources /G.D. Rai

### REFERENCES:

1. Renewable Energy Sources /Twidell & Weir
2. Solar Energy /Sukhatme
3. Solar Power Engineering / B.S Magal Frank Kreith & J.F Kreith.
4. Principles of Solar Energy / Frank Krieth & John F Kreider.
5. Non-Conventional Energy / Ashok V Desai /Wiley Eastern.
6. Non-Conventional Energy Systems / K Mittal /Wheeler
7. Renewable Energy Technologies /Ramesh & Kumar /Narosa

## GROUND WATER HYDROLOGY, WELLS AND PUMPS

**Objective:** To enable the students to acquire knowledge on aquifers and estimation of their different properties like hydraulic conductivity, transmissibility, storage coefficient, specific yield, leakage factor, hydraulic resistance under steady and unsteady state conditions in wells dug under different aquifers, well drilling and development methods and equipment design of gravel pack in bore well. Further to make the students to acquire knowledge on various pumps available commercially, their selection, operation and maintenance with due importance to find out the cost of operation

**Unit – I:** Water Resources status of India-Occurrence and Movement of ground water and Aquifers – Types of Water bearing formations – unconfined, confined, semi confined aquifers – perched water table condition – diagrammatic representation.

**Unit – II:** Classification of wells – Design of open wells – Ground water replenishment – Ground water exploration –Methods of drilling of wells – Common well drilling difficulties – Gravel packing – well screens – Development of well -

**Unit – III:** Aquifer characteristics influencing yield of wells - Determination of aquifer parameters – Steady state and unsteady state conditions – Well interference and multiple well point systems in coastal areas.

**Unit – IV:** Surface and subsurface exploitation and estimation of ground water potential – Artificial ground water recharge – Ground water project formulation – Classification of indigenous pumps – Wind powered water lifts – Solar powered and biogas operated water lifts – Reciprocating pumps -

**Unit – V:** centrifugal pumps – Terminology on Horse Power – Selection of pump-installation and trouble shooting of pumps – performance characteristic curves – Effect of change of impeller dimensions on performance characteristics

**Unit – VI:** Hydraulic Ram – Propeller pumps - Mixed flow pumps - Air lift pumps – Priming – Vertical Turbine pumps – Submersible pumps – Cost economics

### REFERENCES:

1. Ground water and tube wells - Garg S P 1985. Oxford and IBH publish in company limited, New Delhi.
2. Water Well land Pump Engineering – Michael A M and Khepar S T 1989 Tata Mc-Graw Hill Publishing company limited, New Delhi.
3. Irrigation Theory and Practice – Michael A M 2008 Vikas Publishing House Pvt. Ltd, New Delhi.

## PROPERTIES AND STRENGTH OF MATERIALS

**Objective:** To enable the students to know about different materials used for engineering constructions like buildings, roads, farm structures and metals and other materials for manufacturing farm equipment, implements, dairy and food processing equipment.

### Unit- I:

Properties of Engineering Materials, Classifications of Rocks, Sources of Stones and Natural bed of Stones, Properties, Varieties and uses of stones, Properties, Composition and uses of Bricks, Classification and tests of bricks, Properties, varieties and uses of Tiles, Properties, varieties and uses of Lime, Properties, varieties and uses of Cement, Properties, varieties and uses of Cement Mortar, Properties,

### Unit - II

Varieties and uses of Concrete, Properties, varieties and uses of Sand, Properties, varieties and uses of Paints, Properties, varieties and uses of Varnishes, Properties, varieties and uses of Distempers. Characteristics and uses of Glass, Characteristics and uses of Rubber, Characteristics and uses of Plywood, Characteristics and uses of Plastics,

### Unit-III:

Characteristics and uses of Wrought Iron, Characteristics and uses of Cast Iron, Characteristics and uses of Steel, Characteristics and uses of Aluminium, Characteristics and uses of Copper, Characteristics and uses of Nickel, Alloys of Aluminium and its properties, Alloys of Copper and its properties, Alloys of Nickel and its properties, Definition and Types of Timber, Seasoning of Timber, Industrial Timber and uses of Timber, Methods of heat treatment of Steel.

### Unit-IV:

Introduction – Stresses, Tensile, Compressive and Shear-strains, Units-Elastic Curve- Elastic Limit – Poissons Ratio, Stresses in uniformity tapered circular sections- Stresses in bars of composite , Sections, Thermal Stresses and Strains in simple bars and composite bars, Elastic Constants-Young's Modulus (E), Bulk Modulus  $9K0$  and shear Modulus (G)- Relation between them, Stresses on oblique planes, Mohr's Circle method- Direct stresses in one plane, Direct Stresses in two planes- accompanied by shear stress. Deflection of beams, Relation between slope, deflection and radius of curvature. Methods of finding out slopes & deflections of beams, Double integration method. Slope and Deflection equations off a simply supported beam with a central point load, simply supported beam with eccentric point load. Simply supported beam with a uniformly distributed load, Columns and Struts

### Unit-V:

Euler's column theory. Assumptions of Euler's column theory, Buckling load-derivations, Types of end conditions of columns; both ends hinged, both ends fixed, one end fixed and other hinged, Expression for buckling load of a column with one end fixed other free- with one end fixed and other hinged Expression for buckling load of a column with both ends hinged- with both ends. Fixed Types of end conditions of columns; both ends hinged, both ends fixed, one end fixed and other is hinged & one end fixed and other end is free. Types of end conditions of columns; both ends hinged, both ends fixed, one end fixed and other is hinged & one end fixed and other end is free. Limitations of euler's formula- Rankine's formula for columns.

### Unit-VI:

Riveted joints, types of joints- strength of a rivet and riveted joint-efficiency of a riveted joint Design of riveted joints, Eccentric riveted connections, Welded joint, types of welded joints, Strength of welded joints, technical terms. Design of welded joints, eccentric welded joints. Design of welded joints, eccentric welded joints. Dams, forces acting, stressed at the base of dam. Stability of dams, design of base width of dams. Propped cantilever and beams – Deflection and Slope Equations, Fixed and continuous beams – Deflection and Slope Equations, Super position theorem – claypeyron's theorem of three moments, Application of Clayperon's theorem of three moments, Moment distribution methods. Analysis of statistically indeterminate beams.

**TEXT BOOKS:**

1. Engineering Materials, Rangwala, S.C.1994. Charotar Publishing House, Anand.
2. Strength of Materials by Ramamrutham S. 2003. Dhanapathrai & Sons, Nai Sarak, New Delhi.

**REFERENCES:**

1. Material of constructions Deshpande R S 1977. United Book Corporation, Poona.
2. Manufacturing Process. Hazra Choudhury 1985. Media Promoters and Publishers Private Limited, Bombay.
3. Workshop Technology (Part-I) Chapman W.A.J. 1994. Aronold Publishers, New Delhi.
4. Engineering Materials. Rangwala S.C. 1994. Charotar Publishing House, Anand.
5. Mechanics of Structures (Vol.I) Junarkar S.B. 2001 - Charotar Publishing House, Anand.

## ELECTRICAL SYSTEMS

### Unit- I:

Independent, Dependent Sources and Kirchoff's Laws, Maxwell's Loop current method and its problems, Nodal Voltage Method and its problems, Thevenin's Theorem and its problems, Norton's Theorem and its problems, Superposition Theorem and its problems, Reciprocity and Maximum power Transfer, Star-Delta Conversion Method and its problems.

Solution of DC circuit by Network Theorems, Sinusoidal steady state response of circuits, Instantaneous and Average Methods, Concept of Power Factor, Reactive and Apparent Power, Concept and Analysis of Balanced Polyphase circuits, Laplace Transform method of finding step response of DC circuits, Series and Parallel Resonance.

### Unit-II:

Electromotive force, Reluctance, Magnetic circuit, Determination of Ampere Turn Hysteretic losses and eddy current losses, Transformer-working principle, Construction of single phase transformer, EMF equation of transfer, Core type transformer, shell type and difference between shell and core type transformer, Electric circuit, dielectric insulation, leakage reactance in transformer.

### Unit III:

Voltage regulation, transformer test, open circuit and short circuit tests, Losses in a transformer efficiency of transformer, condition for maximum efficiency, Equivalent circuit of transformer, theory of an ideal transformer, Phasor diagram of an ideal transformer, transformer on non load, Phasor diagram of transformer on load, problems solved. DC Generator, Principle of working construction, field system, armature, Commutator, other accessories of DC generator, EMF equation of DC generator, Torque equation, DC armature winding, lap winding wave winding terms used in armature winding, Armature reaction, Demagnetizing & Cross magnetizing ampere turns, methods of compensating armature reaction.

### Unit – IV

Excitation of DC generator-shunt generator, series generator, compound generator, Commutation-Resistance commutation, EMF commutation, Characteristics of DC generator-separately excited, shunt, series, compound generator, DC Motor-working principle, value of back EMF, voltage equation of DC motor, Characteristics of DC motor-Characteristics of series, shunt, compound motor, Torque of DC motor, Armature Torque, shaft Torque-efficiency of DC motor.

### Unit-V:

Factors controlling the speed, Flux control and armature control of shunt motors, Motors starters and their necessity, shunt motor and series motor starter, Principle of operation of single phase induction motor, double field revolving theory Equivalent circuit of single phase induction motor without core loss and with core loss, Single phase – split induction motor, shaded pole, motor, Power factor, disadvantage low power factor, power factor improvement.

### Unit – VI

Measurement of power in three phase system, single watt meter, two watt meter method, Measurement of power in single phase system, using current transformer and voltage transformer, Three phase induction motor – working principle, production of rotation field, Construction – Starter, rotor, operation, Torque equation, Starting (DOL, Autotransformer, Star delta starter) and speed control methods.

### TEXT BOOKS:

1. A text book of Electrical Technology Vol. II -Theraja BL & Theraja A K 2005. S. Chand & Company Ltd., New Delhi.

### REFERENCES:

1. Basic Electrical Engineering, ANWANI M L 1997. Dhanpat Rai & Co. (P) Ltd. New Delhi.
2. Electrical Engineering Fundamentals, Vincent DelToro 2000. Prentice – Hall of India (P) Ltd., New Delhi



## SURVEYING

### UNIT – I

**INTRODUCTION:** Overview of plane surveying (chain, compass and plane table), Objectives, Principles and classifications. Distance measurement conventions and methods; use of chain and tape, Electronic distance measurements, Meridians, Azimuths and Bearings, declination, computation of angle.

### UNIT – II

**LEVELING AND CONTOURING:** Concept and Terminology, Temporary and permanent adjustments- method of leveling. Characteristics and Uses of contours- methods of conducting contour surveys and their plotting.

### UNIT – III

**COMPUTATION OF AREAS AND VOLUMES:** Area from field notes, computation of areas along irregular boundaries and area consisting of regular boundaries. Embankments and cutting for a level section and two level sections with and without transverse slopes, determination of the capacity of reservoir, volume of barrow pits.

### UNIT - IV

**THEODOLITE:** Theodolite, description, uses and adjustments – temporary and permanent, measurement of horizontal and vertical angles. Principles of Electronic Theodolite. Trigonometrical leveling, Traversing.

### UNIT – V

#### **TACHEOMETRIC SURVEYING:**

Stadia and tangential methods of Tacheometry. Distance and Elevation formulae for Staff vertical position. Types of curves, design and setting out – simple and compound curves.

### UNIT - VI

**INTRODUCTION TO ADVANCED SURVEYING :** Introduction to geodetic surveying, Total Station and Global positioning system, Introduction to Geographic information system (GIS).

#### **TEXT BOOKS:**

1. "Surveying (Vol – 1, 2 & 3), by B.C.Punmia, Ashok Kumar Jain and Arun Kumar Jain - Laxmi Publications (P) Ltd., New Delhi
2. Duggal S K, "Surveying (Vol – 1 & 2), Tata Mc-Graw Hill Publishing Co. Ltd. New Delhi, 2004.
3. Text book of surveying by C. Venkataramaiah, University Press

#### **REFERENCES:**

1. Arthur R Benton and Philip J Taety, Elements of Plane Surveying, McGraw Hill – 2000
2. Arora K R "Surveying Vol 1, 2 & 3), Standard Book House, Delhi, 2004
3. Chandra A M, "Plane Surveying", New age International Pvt. Ltd., Publishers, New Delhi, 2002.
4. Chandra A M, "Higher Surveying", New age International Pvt. Ltd., Publishers, New Delhi, 2002.
5. Surveying and levelling by R. Subramanian, Oxford university press, New Delhi

**FLUID MECHANICS AND OPEN CHANNEL HYDRAULICS LAB**

**Practical:**

1. Determination of metacentric height
2. Verification of Bernoulli's theorem
3. Measurement of discharge with a venturimeter
4. Measurement of velocity with a pilot tube
5. Determination of coefficient of discharge of rectangular weir
6. Determination of coefficient of discharge of triangular weir
7. Determination of coefficient of discharge of trapezoidal weir
8. Determination of hydraulic coefficient of orifices
9. Experiment on broad crested weir
10. Determination of head losses in pipes
11. Experiments on open channels
12. Determination of roughness coefficients of open channels
13. Measurement of velocity and pressure profiles in open channels
14. Construction of flownet
15. Problems on construction of flownet

## SURVEYING LAB

### LIST OF EXERCISES:

1. Survey of an area by chain survey (closed traverse) & Plotting
2. Determination of distance between two inaccessible points with compass.
3. Surveying of a given area by prismatic compass (closed traverse) and plotting after adjustment.
4. Radiation method, intersection methods by plane Table survey
5. Two point and three point problems in plane table survey
6. Fly leveling (differential leveling)
7. An exercise of L.S and C.S and plotting
8. One exercise on contouring.
9. Study of theodolite in detail - practice for measurement of horizontal and vertical angles.
10. Measurement of horizontal angles by method of repetition and reiteration.
11. Trigonometric Leveling - Heights and distance problem (Two Exercises)
12. Heights and distance using Principles of tacheometric surveying (Two Exercises)
13. Area determination, traversing contouring using total station
14. Determination of remote height and state out using total station
15. Distance, gradient, Difference in height between two inaccessible points using total station

### List of Major Equipment:

1. Chains, tapes, Ranging rods, cross staff, arrows
2. Compasses and Tripods, Optical square.
3. Plane tables, Alidade, Plumbing fork, trough compasses
4. Leveling instruments and leveling staves
5. Box sextants, planimeter.
6. Theodolites, and leveling staffs.
7. Tachometers.
8. Total station.

## THEORY OF STRUCTURES

**Objective:** The Students will have acquired knowledge on the design principles of beams, slabs, columns, foundations and RCC structures.

### Unit-I:

Introduction to loads and BIS codes – Analysis and designing of single reinforced sections – Properties of reinforced concrete, advantages, assumptions, modular ratio, equivalent area of R.C.C., Stress and strain diagram, neutral axis, moment of resistance, design of rectangular section.

### Unit-II:

Analysis of balanced over reinforced and under reinforced sections – Under reinforced sections, over reinforced sections, problems. Analysis and designing of double reinforced sections – Modular ratio for compression shell equivalent area of steel in compression, neutral axis, moment of resistance, steel beam theory, problems. Shear stresses in beams – Shear stress induced in homogeneous and R.C. beams, nominal shear stress, varying depth, effect of shear in R.C. beams, failures, shear resistance of concrete without shear reinforcement.

### Unit- III:

Design of shear reinforcement, problems. Vertical stirrups and inclined bars – Development of length, development of stress in R.C.C. Anchorage for reinforced bars–Anchorage for reinforced bars, anchorage bars in tension, anchorage bars in compression. Curtailment of bars – Decision on the curtailment of bars, design considerations for bond, general concept of bond.

### Unit- IV:

Design of flanges beams (CT and I beams). Design of one way slabs – Loading on slabs, arrangement of reinforcement, design of one way slab. Design of one way slabs – Problems on design of one way slabs. Design of one way slabs – Design of reinforced brick slabs, problems. Design of one way slabs – Rankine – Grashoff theory, shear force on the edges, design, problems, Merco's method.

### Unit-V:

Design of two way slabs – Torsion reinforcement, load and bending moment, problems, slabs with edges fixed. Design of two way slabs – Provision of torsion reinforcement, Marcor's method, problems. Axially loaded columns – Types of columns, effective length of columns, long and short columns, composite columns.

### Unit- VI:

Axially loaded columns – Basic rules for design of columns, arrangement of transverse reinforcement, problems. Foundations – Types of foundations, design criteria. Foundations – Problems on design criteria. Retaining walls – Earth pressure on a retaining wall, active earth pressure, passive earth pressure. Stability of walls – Conditions for stability of retaining walls, problems.

### TEXT BOOKS:

1. Mechanics of Structures Vol. I, Junarkar,S.B. 2001 – Charotar Publishing Home, Anand.
2. Mechanics of Materials, Dr. B.C. Punmia, Laxmi Publications.

### REFERENCES:

- 1.Strength of materials, R.S. Khumi 2001 – S. Chand & Company Ltd., 7361, Ram Nagar, New Delhi – 110055.
- 2.Treasure of R.C.C. Design, Sushil Kumar 2003 – R.K.Jain – 1705-A, Nai Sarak, Delhi

**HEAT AND MASS TRANSFER**

**Objective:** To enable the students to know about the transport phenomenon in materials through heat and mass transfer for applications in unit operations of dairy and food engineering.

**Unit – I:**

Introductory concepts, application of Heat and mass transfer-modes of heat transfer examples, Fourier's law of heat transport, Introduction to steady state heat transfer –one dimensional steady state heat conduction equation.

Thermal conductivity of different materials – measurement-Insulation Materials, One dimensional steady state conduction through plane and composite walls, Conduction through tubes and spheres with and without heat generation, Conduction through multilayer tubes.

**Unit – II:**

Electrical analogy-conduction through materials in parallel, Combined convection and conduction and overall heat transfer coefficients-problem solving, Concept of critical thickness of insulation for a cylinder-problem solving,

**Unit III:**

Radiation heat transfer-Introduction. Absorptivity, reflectivity and transmissivity. Black body and monochromatic radiation, Plank's law, Stefan-Boltzman law, Kichoff's law, grey bodies and emissive power, solid angle intensity of radiation, Radiation exchange between black surfaces, geometric configuration factor. Heat transfer analysis involving conduction, convection and radiation by networks.

**Unit IV:**

Unsteady state heat transfer-unsteady state system with negligible internal thermal resistance-equation for different geometries, Fins-heat transfer from extended surfaces-types of fins-numiricals, Free and force convection.

Newton's law of cooling, heat transfer coefficient in convection. Dimensional analysis of free and forced convection. Useful non dimensional numbers and empirical relationships for free and forced convection,

**Unit V:**

Equation of laminar boundary layer on flat plate and a tube, Laminar forced convection on a flat plate and in a tube, Combined free and forced convection, Types of heat exchangers, fouling factor, log mean temperature difference, heat exchanger performance, transfer units, Heat exchanger analysis restricted to parallel and counter flow heat exchangers.

**Unit – VI:**

Steady state molecular diffusion in fluids at rest and in laminar flow-Flick's law mass transfer coefficients-Reynold's analogy.

**REFERENCES:**

1. Transport processes and Unit Operations, Geankoplis C.J. 1992. Allyn and Bacon Inc., Newton, Massachusetts.
2. Heat Transfer, Holman JP 1989. McGraw Hill Book Co., New Delhi.
3. Fundamentals of Heat and Mass Transfer, Incropera F P and De Witt D P 1980 John Wiley and Sons. New York.
4. Engineering Heat Transfer, Gupta CP and Prakash R 1994. Nem Chand and Bros., Roorkee.
5. Heat transfer, Rajput S. Chand & Co, New Delhi.

## THEORY OF MACHINES

**Objective:** To educate the students about the kinematics of machine elements, links and pairs and other systems in different machines for applications in the manufacturing of machines and their elements.

### Unit-I:

Introduction, Element, Link, Pairs. Kinematics Chains and Pairs- Types, lower and higher pairs. Mechanism – types and inversions. Lower and higher pairs. Four bar chain, slider crank chain and their inversions - Determination of velocity and acceleration using graphical (relative velocity and acceleration) methods. Instantaneous center – Lindring.

### Unit II

Types of gears, Law of gearing. Velocity of sliding between two teeth in mesh Involute and cycloidal profile for gear teeth. Spur gear, nomenclature, interference and undercutting. Introduction to helical, spiral, bevel and worm gear. Simple, compound, reverted and epicyclic gear trains - Determining the velocity ratio by tabular method. Turning moment Diagrams, Coefficient of fluctuation of speed and energy.

### Unit-III:

Weight of fly wheel, flywheel applications. Belt drives, types of drives. Belt materials, Length of belt, Power transmitted, Velocity ratio, Belt size for flat and v-belts.

### Units-IV:

Effect of centrifugal tension, creep and slip on power transmission, chain drives Types of friction, Laws of dry friction, Friction of pivots and collars. Single disc, Multiple disc and cone clutches. Rolling friction, Anti-friction bearings.

### Unit -V

Types of Governors, Constructional details and analysis of Watt, Porter and Proell governors – Spread of governors. Effect of friction, controlling force, curves, sensitiveness, stability, hunting, Isochronism's, power and effort of a governor,

### Unit-VI:

Static and dynamic balancing, Balancing of rotating masses in one and different planes, Partial primary balancing of reciprocating masses. Cams and Follower.

### TEXT BOOK:

1. Theory of Mechanisms and Machines Jgdish Lal 1991. Metropolitan Book Co. Pvt. Ltd., 1 Netaji Subash Marg, New Delhi.
2. Theory of Machines, Khurmi R S and Gupta JK 1994. Eurasia Publishing House Pvt. Ltd., Ram Nagar, New Delhi.

### REFERENCES:

- 1 Theory of Machines, Thomas Bevan 1984. CBS Publishers
- 2 Theory of Machines, Ballaney P L 1985 Khanna Publishers, 2- B Nath Market, Nai Sarak, New Delhi
3. Mechanisms and Machine Theory, Rao J S and Dukkippatti R V 1990. Wiley Astern Ltd., New Delhi
4. Theory of Machines, Rattan S B 1993. Tata McGraw Hill Publishing Co. Ltd., 12/4 Asf Ali Road, New Delhi

### SOIL MECHANICS

**Objective:** Students will be trained on concepts and analysis of soil properties, stress conditions of loaded soil, consolidation and soil failure theories. The knowledge imparted will be used in higher level design considerations for construction of soil and water conservation structures, irrigation and drainage structures.

**Unit-I:**

Introduction of soil mechanics – Field of Soil Mechanics. Soil on three phase systems – Physical and index properties of soil. Classification of soils - General, Particle size classification. Classification of soils - textural classification, I.S. classification. Stress condition in soils – Effective and neutral stress.

**Unit-II:**

Concept on Bousinesq's analysis – Vertical pressure distribution on vertical line, vertical pressure under a uniformly loaded circular area, vertical pressure due to a line load. Concept on Bousinesq's analysis – Vertical pressure under strip load, vertical pressure under a uniformly loaded rectangular area, equivalent point load method. Concept on Westerguard's analysis – Point load pressure distribution, uniformly loaded circular area. Westerguard's analysis – Uniformly loaded rectangular area, comparisons between Bousinesq's and Westerguard's solutions. Newmark's influence chart – Preparation, problems.

**Unit-III:**

Shear strength – Introduction, Mohr's stress circle, stress systems with principal planes parallel to the coordinate axes. Shear strength – Introduction, Mohr's stress circle, stress systems with principal planes parallel to the coordinate axes. Shear strength – Mohr – Coulomb failure theory, effective stress principle. Measurement of shear strength – Introduction, direct shear test, tri-axial compression test, stress conditions in soil specimen during tri-axial testing. Measurement of Shear strength – Advantages of tri-axial test, graphical solutions, unconfined compression test, vane shear test. Problems on shear strength.

**Unit-IV:**

Compaction of Soils – Standard test and Modified proctor test. Abbot Compaction test. Jodhpur mini compaction test. Field compaction method and control.

**Unit – V:**

Consolidation of soil – one dimensional analysis spring analogy–Terzaghi's theory. Laboratory consolidation test. Calculation of coefficient of volume change – Coefficient of consolidation.

**Unit-VI:**

Earth pressure – Plastic equilibrium in soils. Active and Passive states of earth pressure. Rankine's theory of earth pressure. Earth pressure for cohesive soils. Simple numerical Exercises on earth pressure. Stability of slopes – infinite and finite slopes. Friction Circle method. Taylor's stability number.

**TEXT BOOK:**

1. Soil Mechanics and Foundations, Punmia B C, Jain A K and Jain A K, 2005. Laxmi Publications (p) LTD. New Delhi

**REFERENCES:**

1. Basic and Applied Soil Mechanics, Gopal Ranjan and Rao A S R 1993. Willey Eastern Ltd., New Delhi.
2. Soil Engineering Vol.1, Alam Singh 1994. CBS Publishers, and Distributions, Delhi.

## SURFACE WATER HYDROLOGY

**Objective :** To enable the students to acquire knowledge and skills on hydrological (rainfall and runoff) measurements in watersheds, hydrological design of structures, prediction of volume and rates of runoff with tools like hydrographs and unit hydrographs, reservoir planning with flood routing techniques for application in natural resources management.

### Unit-I:

Hydrology-definition, hydrology cycle and its components. Forms of Precipitation Rainfall, Characteristics of rainfall in India (types of monsoon). Measurement of Rainfall – Recording and Non-Recording Rain gauges- Rain gauge network density for different topographic conditions – Point rainfall analysis - Presentation of Rainfall data – Mass Curve and hyetograph, Mean Precipitation over an area – Arithmetic Mean, Thiessen Polygon, Isohyetal methods, DAD Relationships and curves. Probability Analysis of Rainfall – Return Period, Plotting position by Weibull's method – Rainfall events at different probability levels ( 20% , 40%, 60%, 80%)

### Unit-II:

Intensity-Duration-Frequency-Relationship ( $i = (KT^x)/(D+A)^n$ ) Determination of net effective rainfall-infiltration indices- Phi index. Runoff-definition-components of runoff-direct runoff and base flow, overload flow and interflows, pictorial representation of different routes of runoff. Runoff characteristics of streams – perennial, intermittent and ephemeral streams, Measurement of stream flows.

### Unit-III:

Measurement of stage and velocities, staff gauge, wire gauge, automatic stage recorders, current meters (horizontal and vertical axis meters), calibration ( $V = a N_s + b$ ). Rainfall-Runoff relations ( $R = a P + b$ ), curve fitting and determination of 'a' and 'b' and (correlation coefficient), factors affecting runoff. Definition and Estimation of peak runoff and design peak runoff rate, rational method and curve number techniques.

### Unit-IV:

Hydrographs-definitions and components, factors affecting flood hydrographs, hydrograph separation for simple and complex storms – Method I (straight line method,  $N = b A^{0.2}$ ), other Methods II and III. Unit Hydrographs-concept and the three implications of the definitions and the two basic assumptions (linear response and time invariance). Effects of the characteristics of storms(duration of rain, time-intensity pattern, areal distribution of runoff and amount of runoff) on the shape of the resulting hydrographs .Derivation of Unit hydrographs, average unit hydrographs from several storms of the same duration (proper procedure of computing average peak flow and time to peak). Derivation of unit hydrographs for complex storms.

### Unit-V:

The conversion of unit hydrograph duration, methods for unit hydrographs of different durations, (1) method of superposition and (2) S-curve. S-curve method, explanation of concept and application. conversion of unit graph duration by S-curve method, determination of lower duration graph from the given higher duration graph and vice-versa. Synthetic unit hydrograph, Concept, Snyder' synthetic unit hydrograph, formulas relating hydrograph features (basin lag, Peak flow and time base of the unit hydrograph). Instantaneous unit hydrograph, Concept and application, SCS Triangular Hydrograph - Application of Hydrology - Flood control and Regulation, Flood mitigation, Floodplain mapping, Retards.

**Unit VI :** Flood Routing-introduction, two broad categories of flood routing and channel routing, hydrologic routing and hydraulic routing, basic equations. Hydrologic storage routing, Schematic representation of storage routing, modified Pul's method (semi-graphical method). Explanation of the features of the modified Pul's method. Flood routing through a reservoir by modified Pul's method. Applications of Hydrology in land and water management, watershed management.

### TEXT BOOKS:

1. Engineering Hydrology. Raghunath H.M. 1986. Willey Eastern Limited, New Delhi.
2. Watershed Hydrology, Suresh R. 1997. Standard Publisher and Distributors, New Delhi.



**REFERENCES:**

1. Engineering Hydrology. Subramanyam K. 1984. Tata Mc. Graw – Hill Publishing Co., Limited, New Delhi.
2. Hydrology for Engineers Linsley R.K. Kholer A. & Paul Hus J.L.H. 1988, Mc-Graw Hill Book Co. New Delhi.
3. Watershed Management. Dhruvanarayana, VV. 1990. ICAR Publication, New Delhi.

## FARM POWER AND TRACTOR SYSTEMS

**Objective:** To enable the students for acquiring the knowledge pertaining to systems like transmission system clutch, types of clutches, types of Gear, sliding, constant mesh type tractor power out lets like P. T.O, belt pulley, drawbar, traction theory rolling, resistance, rim pull, crawler tractor.

### Unit-I:

Source of Farm Power – Conventional & Non Conventional Energy Sources - Classification of Tractor and I.C Engines – Study of I.C Engine components and their construction, operating principles and functions – Engine systems and their construction details and adjustment.

### Unit-II:

Valves and valve mechanism – Fuel and air supply stems – Cooling and lubricating systems – Electrical & ignition systems – I.C Engine fuels – their properties – Detonation and knocking in IC engines – Study of properties of coolants, antifreeze and anti corrosion materials – Lubricant types & study of their properties – Engine governing systems. Introduction to transmission system – Power transmission system of Tractor – Functions of a power transmission system. Clutch – Necessity of clutch in a tractor – Essential features of good clutch – Principal working of clutch – Clutch repairs and maintenance.

### Unit-III:

Types of Clutch – Friction clutch, Dog clutch and Fluid coupling – Friction clutch – Single Plate clutch or single disc clutch, Multiple plate clutch or multiple disc clutch, cone clutch. Single Plate clutch or single disc clutch – constructional details and principle of working mechanism. Multiple plate clutch, splinted sleeve clutch type – constructional details and principle of working mechanism Ratchet & Pawl arrangement mechanism – constructional details and principle of working mechanism. Gears – Necessity for providing gear box – selective sliding type & constant mesh type – Mechanical advantage in gears – Torque ratio in Gears – working of Gear box. Differential unit and Final drive – Differential – Functions of crown wheel – Differential lock – functions – Final drive – functions of Final drive.

### Unit-IV:

Fluid coupling and torque connector – Brake mechanism – Requirements of good braking systems – classification of brakes – Mechanical brake and Hydraulic brake – working mechanism. Steering mechanism – Qualities of Steering mechanism, Main parts of steering mechanism Types of steering boxes – working of hydraulic steering. Hydraulic control system – working principals – Basic components of Hydraulic system – Types of hydraulic system – Position control –Draft control – Mixed control – Precautions for hydraulic system.

### Unit-V:

Tractor power out lets – P.T.O. Construction details, Tractor power out let – Belt pulley constructional details, Tractor power out let – Draw bar – construction details. Traction-Traction efficiency – Method for improving traction – Coefficient of traction – Rolling resistance – Wheel Slip or Track slip – Rimpull – crawler tractor.

### Unit-VI:

Tractor testing – Preparation of tests – Types of tests – Test at the main power take off – Test at varying speeds at full load – Test at varying load-Belt or pulley shaft test – Drawbar test-Tractor engine performance. Determination of centre of Gravity – Suspension method – Balancing method – Weighing method. Tractor chassis machines – Functions of chassis frame – Tractor chassis – Mechanics of Tractor chassis.

### TEXT BOOKS:

1. Farm Tractor Maintenance and Repair. Jain. S.C. and Roy C.R. 1984. TMH Publishing Co. Ltd., New Delhi.
2. Tractors and their power units. Lijedhal J.B. Carleton W.M. Turnquist P. K. and Smith D.W. 1984. AVI Publishing Co. Inc., Westport, Connecticut.

### REFERENCES:

1. Elements of Agricultural Engineering. Jagadeshwar Sahay. 1992. Agro Book Agency, Patna.
2. Farm Gas Engines and Tractors. Fred J.R. 1963. Allied Publisher Pvt. Ltd., Bombay.
3. Farm Machines and their Equipment. Nakra C.P., 1986. Dhanpet Rai and Sons. 1982 Nai Sarak, New Delhi.

**SOIL SCIENCE AND AGRONOMY FIELD LAB**

**PART-A**

1. Study of soil profile and collection of soil samples.
2. Determination of bulk density and particle density of soils.
3. Determination of soil texture.
4. Determination of Proctor moisture content.
5. Determination of soil moisture at different tensions.
6. Determination of hydraulic conductivity of soil.
7. Determination of infiltration rate soil.
8. Determination of soil strength and soil colour.
9. Determination of pH and EC of soils.
10. Determination of organic carbon content in soils.
11. Estimation of available P & K of soils.
12. Determination of anions and cations in irrigation water.

Choose any six labs

**PART-B**

1. Visit to college farm.
2. Study of meteorological instruments.
3. Measurement of rainfall and evaporation.
4. Practice of Ploughing.
5. Practice of puddling.
6. Identification of crops and seeds.
7. Identification of manures and fertilizers.
8. Seed bed preparation for nursery.
9. Practice of sowing.
10. Soil moisture estimation by direct method.
11. Practice of fertilizer application.
12. Practice of inter cultivation.
13. Practice of weeding.
14. Practice of harvesting.
15. Practical examination.

Choose any six labs

### MACHINE DRAWING AND COMPUTER GRAPHICS LAB

1. Preparation of manual drawings with dimensions from Model and Isometric drawings of objects and machine components.
2. Assembly drawings of machine components – Screw jack, knuckle joint, stuffing box and cotter joint
3. Drawing of missing views.
4. Dimensioning methods and principles of dimensioning
5. Concept of sectioning, Revolved and oblique section. Explanation of full sectioning and half sectioning concepts.
6. Sectional drawing of simple machine parts – foot step bearing, shaft support, stuffing box
7. Types of rivet heads and riveted joints. Processes for producing leak proof joints. Symbols for different types of welded joints.
8. Square headed and hexagonal nuts and bolts.
9. Different types of lock nuts, studs, machine screws
10. Application of computers for design. Definition of CAD, benefits of CAD.
11. CAD System components & computer hardware for CAD.
12. Explanation of draw tool bar commands in Auto CAD software
13. Drawing of riveted joints and thread fasteners.
14. Computer Graphics for agricultural engineering applications.
15. Practice in the use of basic and drawing commands on AutoCAD.
16. Generating simple 2-D drawings with dimensions using AutoCAD.
17. Small projects using CAD.

#### REFERENCES:

1. Elementary Engineering Drawing. Bhat. N.D. 1995. Charotar Publishing House, Anand.
2. Machine Drawing. Bhatt N.D and Panchal V.M. 1995. Charotar Publishing House, Anand.
3. Machine Drawing. Narayana K.L. Kannaiyah P. and Venkata Reddy K. 1996. New Age International Ltd., New Delhi.
4. Mastering CAD / CAM with Engineering Subscription Card. Ibrahim Zeid, McGraw-Hill Science / Engineering / Math; 1<sup>st</sup> Edition (May 21, 2004).
5. Principals of CAD / CAM / CAE/ Systems. Kunwoo Lee, Addison – Wesley.