

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.

Irrigation and Drainage Engineering

4 (3+1)

Objective

To make the students acquainted with the different methods of irrigation depending on the crop water requirement and the different drainage solutions depending on specific situations

Theory

Major and medium irrigation schemes of India, purpose of irrigation, merits and demerits of irrigation, source of irrigation water, present status of development and utilization of different water resources of the country; Measurement of irrigation water: weir, flumes and orifices and other methods.

Design and lining of irrigation field channels, on-farm structures for water conveyance, control and distribution; Underground pipe conveyance system: components and design; land grading; Criteria for land levelling, land levelling design methods.

Soil-water-plant relationship: Soil properties influencing irrigation management, soil water movement, infiltration, soil water potential, soil moisture characteristics, soil moisture constants,

measurement of soil moisture, moisture stress and plant response; Water requirement of crops: concept of evapotranspiration (ET), measurement and estimation of ET, water and irrigation requirement of crops, depth of irrigation, frequency of irrigation, irrigation efficiencies.

Surface methods of water application: Border, check basin and furrow irrigation- adaptability, specification and design considerations; Water logging-causes and impacts; Drainage, objectives of drainage, familiarization with the drainage problems of the state, drainage coefficient.

Surface drainage, types and design; Sub-surface drainage: purpose and benefits, investigations of design parameters, hydraulic conductivity, drainable porosity, water table etc., types and use of subsurface drainage system, interceptor and relief drains. 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, vertical drainage, bio-drainage, tile drains, mole drain.

Salt balance, reclamation of saline and alkaline soils, leaching requirements; Conjunctive use of fresh and saline waters.

Practical

Measurement of soil moisture by different instruments; Measurement of irrigation water; Measurement of infiltration characteristics; Determination of bulk density, field capacity and wilting point; Estimation of evapotranspiration and water requirement of crops; Study on scheduling of irrigation of field crops; Study of advance, recession and computation of infiltration opportunity time; infiltration by inflow-outflow method; Study on evaluation of border irrigation method; evaluation of furrow irrigation method; evaluation of check basin irrigation method; Study on *in-situ* measurement of hydraulic conductivity by auger hole method; Study on drainage coefficients determination; Study of piezometer, observation well and measurement of water table; Preparation of iso-bath maps; Design of surface drainage systems; Design and installation of subsurface drainage systems; Determination of various chemical properties of soil and water; Study of tile drainage; cost analysis of surface and sub-surface drainage system; Visit to a waterlogged area and study of a drainage project.

Suggested Readings

1. Allen, R. G., Pereira, L. S., Raes, D. and Smith, M. 1998. *Crop Evapotranspiration Guidelines for Computing Crop Water Requirement*. Irrigation and drainage paper 56, FAO of United Nations, Rome.
2. Bhattacharya, A. K. *Drainage Engineering*. ICAR Publications, New Delhi.
3. Bhattacharya, A. K. and Michael, A. M. 2013. *Land Drainage, Principles, Methods and Applications*. Vikas Publication House, Noida (UP).
4. Israelsen, O. W., Hansen, V. E. and Stringham, G. E. 1980. *Irrigation Principles and Practices*. John Wiley & Sons, Inc. USA.
5. Majumdar, D. K. 2013. *Irrigation Water Management Principles*. PHI learning Private Limited, New Delhi.
6. Michael, A. M. 2012. *Irrigation: Theory and Practice*. Vikas Publishing House, New Delhi.
7. Michael, A. M. and Ojha, T. P. 2014. *Principles of Agricultural Engineering*. Vol II. 5th Edition.

- Jain Brothers Publication, New Delhi.
8. Murthy, V. V. N. 2013. *Land and water Management Engineering*. Kalyani Publishers, New Delhi.
 9. Panigrahi, B. 2013. *A Handbook on Irrigation and Drainage*. New India Publishing Agency, New Delhi.
 10. Ritzema, H. P. 1994. *Drainage Principles and Applications*. ILRI Publication 16.

Food and Dairy Engineering

4 (3+1)

Objective

1. To make the students acquainted with the different unit operations in processing and value addition of different dairy and food products
2. To make them understand the different types of equipment and their working principles used for these.

Theory

Introduction to different unit operations in food processing; Process flow charts for preparation of various food products; Mass and energy balance.

Dehydration of foods; dryers for solid foods, construction and operation of direct and indirect type solar dryers, tray dryer, tunnel dryer, vacuum dryer, microwave dryer, freeze dryer, etc.; dryers for liquid foods, construction and operation of drum dryer, spray dryer and vacuum band dryer; Evaporation of food products: principle, different types of evaporators, factors affecting steam economy, multiple effect evaporation, vapour recompression; Thermal processing: thermo-bacteriology, D value, Z value, reaction quotient, process time, different types of retorts and continuous sterilizers, canning process, aseptic processing.

Principles and applications of different non-thermal processing methods as vacuum processing, high pressure processing, PEF processing, Ultrasonication, radiation processing; Principles and applications of novel heating methods, viz. ohmic, infrared and dielectric heating.

Mixing: Theory of mixing of solids and pastes, mixing index, mixers for solids, liquid foods and pastes, viz. tumbling mixer, screw mixer, ribbon mixer, liquid mixers, sigma-blade mixer, anchor and gate agitator; Separation processes: principle and equipment for sedimentation of solids in liquid and solids in air; Principle and operation of tubular bowl centrifuge and disc bowl centrifuge; Filtration: principle, construction and working principles of different types of filters as plate and frame filter press, shell and leaf filter, centrifugal filter, rotary drum filter, continuous belt filter; Membrane separation: principle, characteristics and applications of reverse osmosis, nano-filtration, ultra-filtration and macro-filtration; membrane modules; Extrusion cooking: principle, factors affecting extrusion cooking, single and twin screw extruders.

Unit operations in milk processing: Engineering, thermal and chemical properties of milk and milk products; Principles and equipment related to receiving of milk, pasteurization, sterilization, homogenization, cream separation, preparation of butter, cheese, paneer and ice cream.

Filling and packaging: Selection of different types of packaging materials for different types of food products; Equipment for filling and packaging of liquid foods such as gravity filler, filling