FLUID MECHANICS AND MACHINERY

Course Code: 22ME1106

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

CO 1: describe the types of fluid flow and fluid flow patterns

CO 2: apply Bernoulli's equation to analyze incompressible fluid flows and study laminar flows

CO 3: explain the concepts of boundary layer fluid flows and losses in pipe flows

CO 4: determine the forces exerted by jet of water on vanes and compare working of different turbines

CO 5: explain the working of reciprocating pump and analyze the performance of centrifugal pump

UNIT-I **10 Lectures**

FLUID PROPERTIES AND PRESSURE MEASUREMENT: Mass density, specific weight, specific volume, specific gravity, viscosity, vapor pressure, compressibility, surface tension and capillarity. Fluid pressure at a point, variation of pressure in a fluid, Pascal's law, atmospheric, absolute, gauge and vacuum pressures, manometers - simple manometers, differential manometers.

KINEMATICS OF FLUID FLOW: Velocity and acceleration of fluid particle, types of fluid flow, description of the fluid pattern, continuity equation, rotational and irrotational flows, velocity potential and stream function.

Learning Outcomes: At the end of this unit, the student will be able to

1. explain properties of fluids and their applications (L2)
2. discuss appropriate method for analyzing fluid flows (L2)
3. describe principle of continuity in fluid motion (L2)

UNIT-II **10 Lectures**

DYNAMICS OF FLUID FLOW: Forces acting on fluid in motion, Euler's and Bernoulli's equation (along stream line only), application of Bernoulli's equation - venturi meter, orifice meter and Pitot tube, introduction to vortex motion. Impulse momentum equation - forces on pipe bend.

LAMINAR FLOW: Relation between shear and pressure gradient, steady laminar flow in circular pipes and steady laminar flow between parallel flat plates-both plates at rest **Learning Outcomes:** At the end of this unit, the student will be able to

1. apply conservation laws to derive the governing equations (L3)
2. apply Bernoulli's principle for determining flow in measuring devices (L3)
3. explain laminar flows in circular pipes and between parallel flat plates (L2)

UNIT-III **8 Lectures**

BOUNDARY LAYER THEORY: Introduction, thickness of boundary layer, boundary layer along a long thin plate, boundary layer equations, momentum integral equation of the boundary layer, laminar boundary layer, turbulent boundary layer, laminar sub layer, separation of boundary layer, methods to prevent boundary layer separation.

FLOW THROUGH PIPES: Reynolds experiment, energy loss due to friction - DarcyWeisbach equation, minor energy losses, transmission of power through pipes, flow through nozzle at the end of pipe.

Learning Outcomes: At the end of this unit, student will be able to

1. describe the formation of boundary layer in external flow (L2)
2. explain the conditions leading to boundary layer separation and its control (L2)
3. discuss major and minor losses in pipe flows by applying governing equations(L2)

UNIT-IV **10 Lectures**

IMPACT OF JETS: Force exerted by fluid jet on stationary flat plate and curved vane, force exerted by fluid jet on moving flat plate and curved vane. Torque exerted on a wheel with radial curved vanes.

HYDRAULIC TURBINES: Elements of hydraulic power plants, head and efficiencies of hydraulic turbines, classification of turbines - Pelton wheel, Francis and Kaplan – work done, efficiencies, working proportions and design - draft tube theory. Performance under unit head – unit quantities, performance under specific conditions – specific speed, performance characteristic curves, model testing of turbines.

Learning Outcomes: At the end of this unit, student will be able to

1. calculate the forces exerted by jet on vanes (L3)
2. classify turbines based on principle of operation (L4)
3. analyze the turbine performance under various operating conditions (L4)

UNIT-V **10 Lectures**

RECIPROCATING PUMPS: Main components and working of a reciprocating pump, types of reciprocating pumps, work done by reciprocating pump, coefficient of discharge; slip; ideal indicator diagram.

CENTRIFUGAL PUMPS: Working of centrifugal pump, types of centrifugal pumps, work done by the impeller, head of the pump, losses and efficiencies, minimum starting speed, Specific speed, model testing of pumps, multistage pumps - pumps in series and parallel, performance of pumps-characteristics curves, limitation of suction lift, NPSH, cavitation, priming devices, pump troubles and remedies.

Learning Outcomes: At the end of this unit, student will be able to

1. explain construction and operation of reciprocating and centrifugal pumps (L2)
2. analyze the performance of centrifugal pumps under various operating conditions (L4)

3. discuss the operating characteristics of pumps (L2)

Text Book:

1. P.N. Modi and S.M. Seth, *Hydraulics and Fluid Mechanics including Hydraulic Machines*, 22nd Edition, Standard Publications,2019
2. R.K. Bansal, *Fluid Mechanics And Hydraulic Machines*, 10th Edition, Laxmi Publications, 2018.

References Books:

1. D.S. Kumar, *Fluid Mechanics and Fluid Power Engineering*, 9th Edition, S.K. Kataria and Sons, 2015.
2. K.L.Kumar, *Engineering Fluid Mechanics*, 9th Edition, S.Chand & Co., 2016.
3. Irving H. Shames, Mechanics of fluids, 3rd Edition, Tata McGrawHill, 2013.