SREENIVASA INSTITUTE OF TECHNOLOGY AND MANAGEMENT STUDIES
(AUTONOMOUS)

QUESTION BANK

Year / Semester: II B.Tech / IV Semester **Regulation: R23**

Subject and Code: Fluid Mechanics & Hydraulic Machines & 23MEC241T

23MEC241T FLUID MECHANICS & HYDRAULIC MACHINES **L T P C 3 0 0 3**

PRE-REQUISITES:

COURSE EDUCATIONAL OBJECTIVES:

The students completing this course are expected to

1. Understand the properties of fluids, manometry, hydrostatic forces acting on different surfaces
2. Understand the kinematic and dynamic behavior through various laws of fluids like continuity, Euler's, Bernoulli's equations, energy and momentum equations.
3. Understand the theory of boundary layer, working and performance characteristics of various hydraulic machines like pumps and turbines.

UNIT –1: Fluid statics, Buoyancy and floatation: (9)

Fluid statics: Dimensions and units: physical properties of fluids - specific gravity, viscosity and its significance, surface tension, capillarity, vapor pressure. Atmospheric, gauge and vacuum pressure, Measurement of pressure – Manometers - Piezometer, U-tube, inverted and differential manometers. Pascal's & hydrostatic laws.

Buoyancy and floatation: Meta center, stability of floating body. Submerged bodies. Calculation of meta center height. Stability analysis and applications.

UNIT –2: Fluidkinematics, Fluid dynamics and Closed conduit flow (9)

Fluid kinematics: Introduction, flow types. Equation of continuity for one dimensional flow, circulation and vorticity, Stream line, path line and streak lines and stream tube. Stream function And velocity potential function, differences and relation between them. Condition for irrotational flow, flownet, source and sink, doublet and vortex flow.

Fluid dynamics: surface and body forces –Euler's and Bernoulli's equations for flow along a streamline, momentum equation and its applications, force on pipe bend.

Closed conduit flow: Reynold's experiment- Darcy Weisbach equation- Minor losses in pipes-pipes in series and pipes in parallel-total energy line-hydraulic gradient line.

UNIT –3: Boundary Layer Theory and Dimensional Analysis (9)

Boundary Layer Theory: Introduction, momentum integral equation, displacement, momentum and energy thickness, separation of boundary layer, control of flow separation, Stream lined body, Bluff body an dits applications, basic concepts of velocity profiles.

Dimensional Analysis: Dimensions and Units, Dimensional Homogeneity, Non dimensionalization of equations, Method of repeating variables and Buckingham Pi Theorem.

UNIT –4: Basics of turbo machinery and Hydraulic Turbines (9)

Basics of turbo machinery: hydrodynamic force of jets on stationary and Moving flat, inclined and curved vanes, jet striking centrally and at tip, velocity diagrams, workdone and efficiency, flow Over radial vanes.

Hydraulic Turbines: classification of turbines, impulse and reaction turbines, Pelton wheel, Francis turbine and Kaplan turbine-working proportions, work done, efficiencies, hydraulic design – draft tube- theory-functions and efficiency.

SREENIVASA INSTITUTE OF TECHNOLOGY AND MANAGEMENT STUDIES (AUTONOMOUS)

QUESTION BANK

Year / Semester: II B.Tech / IV Semester **Regulation: R23**

Subject and Code: Fluid Mechanics & Hydraulic Machines & 23MEC241T

UNIT –5: Hydraulic turbines, Centrifugal pumps and Reciprocating pumps (9)

Performance of hydraulic turbines: Geometric similarity, Unit and specific quantities, Characteristic curves, governing of turbines, selection of type of turbine, cavitation, surge tank, water hammer. Hydraulic systems- hydraulic ram, hydraulic lift, hydraulic coupling. Fluidics – amplifiers, sensors and oscillators. Advantages, limitations and applications.

Centrifugal pumps: classification, working, work done – manometric head- losses and efficiencies-specific speed- pumps in series and parallel-performance characteristic curves, cavitation & NPSH. Reciprocating pumps: Working, Discharge, slip, indicator diagrams.

Total Hours: 45

COURSE OUTCOMES:

On successful completion of the course, students will be able to		Pos
CO1	Understand the basic concepts of fluid properties.	**PO1, PO2, PO12**
CO2	Estimate the mechanics of fluids in static and dynamic conditions.	**PO1, PO2, PO3, PO4, PO12**
CO3	Apply the Boundary layer theory, flow separation and dimensional analysis.	**PO1, PO2, PO3, PO4, PO12**
CO4	Estimate the hydrodynamic forces of jet on vanes in different positions.	**PO1, PO2, PO3, PO4, PO12**
CO5	Understand the Working principles and performance evaluation of hydraulic pump and turbines.	**PO1, PO2, PO3, PO4, PO12**

TEXT BOOKS:

1. Y.A.Cengel, J.M.Cimbala, Fluid Mechanics, Fundamentals and Applications,6/e, McGraw Hill Publications, 2019.
2. Dixon, Fluid Mechanics and Thermodynamics of Turbomachinery,7/e, Elsevier Publishers, 2014.

REFERENCE BOOKS:

1. P N Modi and S M Seth, Hydraulics & Fluid Mechanics including Hydraulics Machines, Standard Book House, 2017.
1. R.K.Bansal, Fluid Mechanics and Hydraulic Machines, 10/e, Laxmi Publications (P)Ltd, 2019.
2. Rajput, Fluid Mechanics and Hydraulic Machines, S Chand & Company, 2016.
3. D.S.Kumar, Fluid Mechanics and Fluid Power Engineering, S K Kataria &Sons, 2013.
4. D.Rama Durgaiah, Fluid Mechanics and Machinery,1/e, New Age International, 2002.

SREENIVASA INSTITUTE OF TECHNOLOGY AND MANAGEMENT STUDIES (AUTONOMOUS)

QUESTION BANK

Year / Semester: II B.Tech / IV Semester **Regulation: R23**

Subject and Code: Fluid Mechanics & Hydraulic Machines & 23MEC241T

REFERENCE WEBSITE:

1. https://archive.nptel.ac.in/courses/112/105/112105206/
2. https://archive.nptel.ac.in/courses/112/104/112104118/
3. https://www.edx.org/learn/fluid-mechanics
4. https://onlinecourses.nptel.ac.in/noc20_ce30/previewnptel.ac.in
5. www.coursera.org/learn/fluid-powerera

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO.1	3	2	-	-	-	-	-	-	-	-	-	1
CO.2	3	2	1	1	-	-	-	-	-	-	-	1
CO.3	3	2	1	1	-	-	-	-	-	-	-	1
CO.4	3	2	1	1	-	-	-	-	-	-	-	1
CO.5	3	2	1	1	-	-	-	-	-	-	-	1
CO*	**3**	**2**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**

Prepared by Mr.D.Raju

SREENIVASA INSTITUTE OF TECHNOLOGY AND MANAGEMENT STUDIES (AUTONOMOUS)

QUESTION BANK

Year / Semester: II B.Tech / IV Semester **Regulation: R23**

Subject and Code: Fluid Mechanics & Hydraulic Machines & 23MEC241T

Max Marks: 10

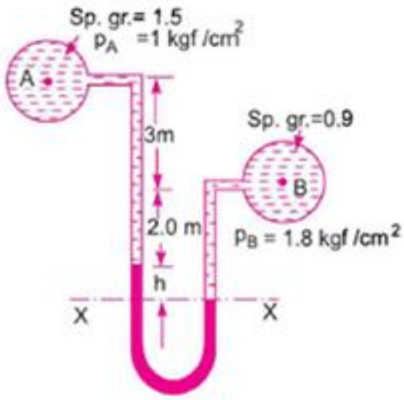
S.No.	CO	Questions	BT
		Unit-I **Fluid Statics, Buoyancy and Flotation**	
1	**1**	**Define viscosity? And derive an expression for coefficient of viscosity.**	L2
2	**1**	*A plate 0.025 mm distant from a fixed plate, moves at 60 cm/s and requires a force of 2 N per unit area i.e., 2 N/m^2 to maintain this speed. Determine the fluid viscosity between the plates.*	L2,L4
3	**1**	*The space between two square flat parallel plates is filled with oil. Each side of the plate is 60 cm. The thickness of the oil film is 12.5 mm. The upper plate, which moves at 2.5 metre per sec requires a force of 98.1 N to maintain the speed. Determine :* *(i) the dynamic viscosity of the oil in poise, and* *(ii) the kinematic viscosity of the oil in stokes if the specific gravity of the oil is 0.95.*	L1
4	**1**	*Calculate the capillary rise in a glass tube of 2.5 mm diameter when immersed vertically in (a) water and (b) mercury. Take surface tensions $\sigma = 0.0725$ N/m for water and $\sigma = 0.52$ N/m for mercury in contact with air. The specific gravity for mercury is given as 13.6 and angle of contact = 130°.*	L2
5	**1**	*Find the kinematic viscosity of an oil having density 981 kg/m^3. The shear stress at a point in oil is 0.2452 N/m^2 and velocity gradient at that point is 0.2 per second.*	L1
6	**1**	*Calculate the capillary effect in millimetres in a glass tube of 4 mm diameter, when immersed in (i) water, and (ii) mercury. The temperature of the liquid is 20°C and the values of the surface tension of water and mercury at 20°C in contact with air are 0.073575 N/m and 0.51 N/m respectively. The angle of contact for water is zero and that for mercury is 130°. Take density of water at 20°C as equal to 998 kg/m^3.*	L2
7	**1**	**Derive an Expression for U-Tube differential manometer with suitable sketch.**	L2

SREENIVASA INSTITUTE OF TECHNOLOGY AND MANAGEMENT STUDIES
(AUTONOMOUS)

QUESTION BANK

Year / Semester: II B.Tech / IV Semester **Regulation: R23**

Subject and Code: Fluid Mechanics & Hydraulic Machines & 23MEC241T

8	**1**	*A differential manometer is connected at the two points A and B of two pipes as shown in Fig. 2. The pipe A contains a liquid of sp. gr. = 1.5 while pipe B contains a liquid of sp. gr. = 0.9. The pressures at A and B are 1 kgf/cm^2 and 1.80 kgf/cm^2 respectively. Find the difference in mercury level in the differential manometer.*  **Fig. 2.**	L2
9	**1**	*Find the volume of the water displaced and position of centre of buoyancy for a wooden block of width 2.5 m and of depth 1.5 m, when it floats horizontally in water. The density of wooden block is 650 kg/m^3 and its length 6.0 m.*	L1
10	**1**	*The dynamic viscosity of an oil, used for lubrication between a shaft and sleeve is 6 poise. The shaft is of diameter 0.4 m and rotates at 190 r.p.m. Calculate the power lost in the bearing for a sleeve length of 90 mm. The thickness of the oil film is 1.5 mm.*	L2

S.No.	CO	Questions	BT
		Unit-II **Fluid kinematics, Fluid dynamics and Closed conduit flow**	
1	**2**	**Discuss in detail of different types of fluid flows.**	L4,L2
2	**2**	**Obtain an expression for continuity equation for two dimensional flow.**	L2

SREENIVASA INSTITUTE OF TECHNOLOGY AND MANAGEMENT STUDIES
(AUTONOMOUS)

QUESTION BANK

Year / Semester: II B.Tech / IV Semester **Regulation: R23**

Subject and Code: Fluid Mechanics & Hydraulic Machines & 23MEC241T

3	**2**	*The diameters of a pipe at the sections 1 and 2 are 10 cm and 15 cm respectively. Find the discharge through the pipe if the velocity of water flowing through the pipe at section 1 is 5 m/s. Determine also the velocity at section 2.*	L4
4	**2**	*A 30 cm diameter pipe, conveying water, branches into two pipes of diameters 20 cm and 15 cm respectively. If the average velocity in the 30 cm diameter pipe is 2.5 m/s, find the discharge in this pipe. Also determine the velocity in 15 cm pipe if the average velocity in 20 cm diameter pipe is 2 m/s.*	L2
5	**2**	*Water is flowing through a pipe of 5 cm diameter under a pressure of 29.43 N/cm^2 (gauge) and with mean velocity of 2.0 m/s. Find the total head or total energy per unit weight of the water at a cross-section, which is 5 m above the datum line.*	L2, L4
6	**2**	*A pipe, through which water is flowing, is having diameters, 20 cm and 10 cm at the cross-sections 1 and 2 respectively. The velocity of water at section 1 is given 4.0 m/s. Find the velocity head at sections 1 and 2 and also rate of discharge.*	L4
7	**2**	**What is venturimeter? Derive an expression for the discharge through a venturimeter.**	L2
8	**2**	*A horizontal venturimeter with inlet and throat diameters 30 cm and 15 cm respectively is used to measure the flow of water. The reading of differential manometer connected to the inlet and the throat is 20 cm of mercury. Determine the rate of flow. Take $C_d = 0.98$.*	L4
9	**2**	*An oil of sp. gr. 0.8 is flowing through a venturimeter having inlet diameter 20 cm and throat diameter 10 cm. The oil-mercury differential manometer shows a reading of 25 cm. Calculate the discharge of oil through the horizontal venturimeter. Take $C_d = 0.98$.*	L5, L2
10	**2**	*An orifice meter with orifice diameter 10 cm is inserted in a pipe of 20 cm diameter. The pressure gauges fitted upstream and downstream of the orifice meter gives readings of 19.62 N/cm^2 and 9.81 N/cm^2 respectively. Co-efficient of discharge for the orifice meter is given as 0.6. Find the discharge of water through pipe.*	L2

SREENIVASA INSTITUTE OF TECHNOLOGY AND MANAGEMENT STUDIES (AUTONOMOUS)

QUESTION BANK

Year / Semester: II B.Tech / IV Semester **Regulation: R23**

Subject and Code: Fluid Mechanics & Hydraulic Machines & 23MEC241T

S.No.	CO	Questions	BT
Unit III: Boundary Layer Theory and Dimensional Analysis			
1	**3**	*Find the displacement thickness, the momentum thickness and energy thickness for the velocity distribution in the boundary layer given by $\frac{u}{U}=\frac{y}{\delta}$, where u is the velocity at a distance y from the plate and u = U at y = δ, where δ = boundary layer thickness. Also calculate the value of δ*/θ.*	**L2**
2	**3**	*For the velocity profile given in problem 13.3, find the thickness of boundary layer at the end of the plate and the drag force on one side of a plate 1 m long and 0.8 m wide when placed in water flowing with a velocity of 150 mm per second. Calculate the value of co-efficient of drag also. Take μ for water = 0.01 poise.*	**L2**
3	**3**	*Air is flowing over a smooth plate with a velocity of 10 m/s. The length of the plate is 1.2 m and width 0.8 m. If laminar boundary layer exists up to a value of $R_e = 2 \times 10^5$, find the maximum distance from the leading edge upto which laminar boundary layer exists. Find the maximum thickness of laminar boundary layer if the velocity profile is given by* $$\frac{u}{U}=2\left(\frac{y}{\delta}\right)-\left(\frac{y}{\delta}\right)^2$$ *Take kinematic viscosity for air = 0.15 stokes.*	**L2**
4	**3**	*A thin plate is moving in still atmospheric air at a velocity of 5 m/s. The length of the plate is 0.6 m and width 0.5 m. Calculate (i) the thickness of the boundary layer at the end of the plate, and (ii) drag force on one side of the plate. Take density of air as 1.24 kg/m^3 and kinematic viscosity 0.15 stokes.*	**L4, L2**
5	**3**	*A plate of 600 mm length and 400 mm wide is immersed in a fluid of sp. gr. 0.9 and kinematic viscosity (ν =) 10^{-4} m^2/s. The fluid is moving with a velocity of 6 m/s. Determine (i) boundary layer thickness, (ii) shear stress at the end of the plate, and (iii) drag force on one side of the plate.*	**L2**
6	**3**	*Determine the dimensions of the quantities given below : (i) Angular velocity, (ii) Angular acceleration, (iii) Discharge, (iv) Kinematic viscosity, (v) Force, (vi) Specific weight, and (vii) Dynamic viscosity.*	**L2**
7	**3**	*The time period (t) of a pendulum depends upon the length (L) of the pendulum and acceleration due to gravity (g). Derive an expression for the time period.*	**L2**

8	**3**	*The resisting force R of a supersonic plane during flight can be considered as dependent upon the length of the aircraft l, velocity V, air viscosity μ, air density ρ and bulk modulus of air K. Express the functional relationship between these variables and the resisting force.*	**L2**
9	**3**	**State Buckingham's π-theorem in detail.**	**L5, L2**
10	**3**	*The frictional torque T of a disc of diameter D rotating at a speed N in a fluid of viscosity μ and density ρ in a turbulent flow is given by* $T = D^5N^2\rho\phi\left[\frac{\mu}{D^2N\rho}\right]$. *Prove this by the method of dimensions.*	**L2**

S.No.	CO	Questions	BT
Unit IV: Basics of Turbo Machinery and Hydraulic Turbines			
1	**4**	**Obtain an expression for the force exerted by the jet on a stationary vertical plate in the direction of jet.**	**L2**
2	**4**	**Obtain an expression for the force exerted by the jet on an inclined moving plate in the direction of jet.**	**L2**
3	**4**	*A jet of water of diameter 75 mm moving with a velocity of 25 m/s strikes a fixed plate in such a way that the angle between the jet and plate is 60°. Find the force exerted by the jet on the plate (i) in the direction normal to the plate and (ii) in the direction of the jet.*	**L2**
4	**4**	*A jet of water of diameter 75 mm moving with a velocity of 30 m/s, strikes a curved fixed plate tangentially at one end at an angle of 30° to the horizontal. The jet leaves the plate at an angle of 20° to the horizontal. Find the force exerted by the jet on the plate in the horizontal and vertical direction.*	**L2**

SREENIVASA INSTITUTE OF TECHNOLOGY AND MANAGEMENT STUDIES (AUTONOMOUS)

QUESTION BANK

Year / Semester: II B.Tech / IV Semester **Regulation: R23**

Subject and Code: Fluid Mechanics & Hydraulic Machines & 23MEC241T

5	**4**	*A jet of water of diameter 10 cm strikes a flat plate normally with a velocity of 15 m/s. The plate is moving with a velocity of 6 m/s in the direction of the jet and away from the jet. Find: (i) the force exerted by the jet on the plate (ii) work done by the jet on the plate per second. and (iii) power and efficiency of the jet.*	**L2, L4**
6	**4**	**Draw a layout of hydroelectric power plant and explain its working briefly.**	**L2**
7	**4**	**Derive an expression for pelton wheel turbine.**	**L2**
8	**4**	*A Pelton wheel has a mean bucket speed of 10 metres per second with a jet of water flowing at the rate of 700 litres/s under a head of 30 metres. The buckets deflect the jet through an angle of 160°. Calculate the power given by water to the runner and the hydraulic efficiency of the turbine. Assume co-efficient of velocity as 0.98.*	**L2, L4**
9	**4**	*A Francis turbine with an overall efficiency of 75% is required to produce 148.25 kW power. It is working under a head of 7.62 m. The peripheral velocity = $0.26\sqrt{2gH}$ and the radial velocity of flow at inlet is $0.96\sqrt{2gH}$. The wheel runs at 150 r.p.m. and the hydraulic losses in the turbine are 22% of the available energy. Assuming radial discharge, determine : (i) The guide blade angle, (ii) The wheel vane angle at inlet, (iii) Diameter of the wheel at inlet, and (iv) Width of the wheel at inlet.*	**L2**
10	**4**	*A Kaplan turbine runner is to be designed to develop 9100 kW. The net available head is 5.6 m. If the speed ratio = 2.09, flow ratio = 0.68, overall efficiency = 86% and the diameter of the boss is 1/3 the diameter of the runner. Find the diameter of the runner, its speed and the specific speed of the turbine.*	**L2**

SREENIVASA INSTITUTE OF TECHNOLOGY AND MANAGEMENT STUDIES (AUTONOMOUS)

QUESTION BANK

Year / Semester: II B.Tech / IV Semester **Regulation: R23**

Subject and Code: Fluid Mechanics & Hydraulic Machines & 23MEC241T

S.No.	CO	Questions	BT
		Unit V **Hydraulic Turbines, Centrifugal Pumps and Reciprocating Pump**	
1	5	**What is a centrifugal pump? Describe the principle and working of a centrifugal pump with a neat sketch.**	L2
2	5	*The internal and external diameters of the impeller of a centrifugal pump are 200 mm and 400 mm respectively. The pump is running at 1200 r.p.m. The vane angles of the impeller at inlet and outlet are 20° and 30° respectively. The water enters the impeller radially and velocity of flow is constant. Determine the work done by the impeller per unit weight of water.*	L2
3	5	*A centrifugal pump is to discharge 0.118 m^3/s at a speed of 1450 r.p.m. against a head of 25 m. The impeller diameter is 250 mm, its width at outlet is 50 mm and manometric efficiency is 75%. Determine the vane angle at the outer periphery of the impeller.*	L2
4	5	*A centrifugal pump delivers water against a net head of 14.5 metres and a design speed of 1000 r.p.m. The vanes are curved back to an angle of 30° with the periphery. The impeller diameter is 300 mm and outlet width is 50 mm. Determine the discharge of the pump if manometric efficiency is 95%.*	L2
5	5	*The outer diameter of an impeller of a centrifugal pump is 400 mm and outlet width is 50 mm. The pump is running at 800 r.p.m. and is working against a total head of 15 m. The vanes angle at outlet is 40° and manometric efficiency is 75%. Determine :* *(i) velocity of flow at outlet, (ii) velocity of water leaving the vane,* *(iii) angle made by the absolute velocity at outlet with the direction of motion at outlet, and* *(iv) discharge.*	L2
6	5	*Find the number of pumps required to take water from a deep well under a total head of 89 m. All the pumps are identical and are running at 800 r.p.m. The specific speed of each pump is given as 25 while the rated capacity of each pump is 0.16 m^3/s.*	L2
7	5	*A single-acting reciprocating pump, running at 50 r.p.m., delivers 0.01 m^3/s of water. The diameter of the piston is 200 mm and stroke length 400 mm. Determine :* *(i) The theoretical discharge of the pump, (ii) Co-efficient of discharge, and (iii) Slip and the percentage slip of the pump.*	L2

Prepared by Mr.D.Raju

SREENIVASA INSTITUTE OF TECHNOLOGY AND MANAGEMENT STUDIES (AUTONOMOUS)

QUESTION BANK

Year / Semester: II B.Tech / IV Semester **Regulation: R23**

Subject and Code: Fluid Mechanics & Hydraulic Machines & 23MEC241T

8	5	*A double-acting reciprocating pump, running at 40 r.p.m., is discharging 1.0 m^3 of water per minute. The pump has a stroke of 400 mm. The diameter of the piston is 200 mm. The delivery and suction head are 20 m and 5 m respectively. Find the slip of the pump and power required to drive the pump.*	L2
9	5	**What is a reciprocating pump? Describe the principle and working of a reciprocating pump with a neat sketch.**	L2
10	5	**What is negative slip in a reciprocating pump? Explain with neat sketches the function of air vessels in a reciprocating pump.**	L4

Note: L1-Remembering, L2-Understanding, L3-Applying, L4-Analyzing, L5-Evaluating, and L6-Creating

Instruction to Faculty Members:

The Six Levels of Bloom's Taxonomy:

1. **Remembering:** Retrieving, recognizing, and recalling relevant knowledge from long-term memory (e.g., list, define, name, locate).
2. **Understanding:** Constructing meaning, explaining ideas, or concepts (e.g., summarize, interpret, classify, compare).
3. **Applying:** Using information in new situations or implementing procedures to solve problems (e.g., solve, use, demonstrate, implement).
4. **Analyzing:** Breaking material into constituent parts, determining how the parts relate to one another and to an overall structure (e.g., contrast, categorize, distinguish, diagram).
5. **Evaluating:** Making judgments based on criteria and standards through checking and critiquing (e.g., judge, critique, justify, defend, argue).
6. **Creating:** Putting elements together to form a coherent or functional whole; reorganizing elements into a new pattern or structure (e.g., design, construct, develop, formulate).