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# P.E.S. College of Engineering, Mandya - 571 401

*(An Autonomous Institution affiliated to VTU, Belagavi)*

## Third Semester, B.E. - Industrial and Production Engineering

## Semester End Examination; March / April - 2022

## Fluid Mechanics and Hydraulic Machines

*Time: 3 hrs* *Max. Marks: 100*

***Course Outcomes***

*The Students will be able to:*

*CO1: Explain the properties of fluid like density, specific weight, specific gravity, viscosity etc; estimate the variations of pressure in a static mass of fluid, and Applying Pascal's Law.*

*CO2: Explain the principles of fluid kinematics involving different types of flows, velocity and acceleration, continuity equation.*

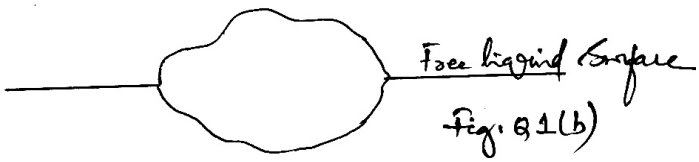
*CO3: Derive the equations of motion and explain fluid flow measurement devices like Venturimeter, orifice meter etc.; evaluate the energy losses in pipe flow.*

*CO4: Explain the operation of energy producing devices like turbines through velocity triangles knowing fully the principles of impact of jets on vanes.*

*CO5: Draw the velocity triangles to explain the working of energy absorbing device like centrifugal pump and the working principle of reciprocating pum.*

***Note**: I) **PART - A** is compulsory. **Two** marks for each question.*

*II) **PART - B**: Answer any **Two** sub questions (from a, b, c) for Maximum of **18 marks** from each unit.*

| Q. No. | | Questions | Marks | BLs | COs |
|---|---|---|---|---|---|
| | | **I : PART - A** | **10** | | |
| I | a. | If a certain liquid weights 10.53 kN/m$^3$, what is its specific gravity? | 2 | L3 | CO1 |
| | b. | Fig. Q1 (b), shows a body floating in its stable equilibrium condition in a static mass of liquid. Copy this figure in your answer script. Show the forces acting on this body and the line of action of the same.   Fig. Q1(b) | 2 | L2 | CO2 |
| | c. | Differentiate between steady and uniform flow. | 2 | L2 | CO3 |
| | d. | In reaction turbines, the water is made to flow in air tight casing which surrounds the rotor whereas rotor of an impulse turbine can rotate freely in air. Explain briefly the reasons for the same. | 2 | L2 | CO4 |
| | e. | Define specific speed of a centrifugal pump. | 2 | L1 | CO5 |
| | | **II : PART - B** | **90** | | |
| | | **UNIT - I** | **18** | | |
| 1 | a. | Write expression for the following and explain their significance:<br>i) Newton's law of viscosity<br>ii) Hydrostatic law<br>iii) Pascal's law | 9 | L2 | CO1 |

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|---|---|---|---|---|
| b. | A pipe contains an oil of specific gravity 0.8. A differential manometer connected at any two points *A* and *B* of the pipe shows a difference in the mercury land as 20 cm. Find the difference of pressure at these two points in terms of the flowing fluid and Pascal's. Sketch the arrangement. | 9 | L3 | CO1 |
| c. | Determine the intensity of shear of an oil having viscosity 1.2 poise and is used for lubrications in the clearance between a 10 cm diameter shaft and its journal bearing. The clearance is 1.0 mm and the shaft rotates at 200 rpm. | 9 | L3 | CO1 |

**UNIT - II** **18**

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| 2 a. | A circular lamina 2 m in diameter is immersed in water so that its greatest and least depths measured vertically below the water surface is 2.5 m and 1 m respectively. Find the total pressure force and the center of pressure due to the water acting on one side of the lamina | 9 | L3 | CO2 |
| b. | Fig. Q2 (b)(a), shows a body of cross sectional area 'a' floating in its stable equilibrium condition in a static mass of liquid. If 'w' is the specific weight of the liquid, what is the magnitude of the buoyant force? If this body is tilted as shown in Fig Q2(b)(b), locate the new center of buoyancy and the position of meta center. Is this equilibrium stable? Write an expression for the magnitude of the couple produced. Also draw the body in its tilted positions for the other two equilibrium conditions showing the positions of meta center with respect to the center of the gravity and name the type of equilibrium. | 9 | L3 | CO2 |

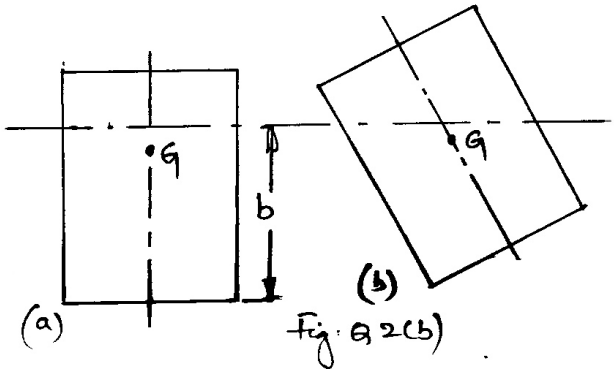

Fig. Q2(b)

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|---|---|---|---|---|
| c. | Derive an expression for total pressure force and center of pressure for a vertical plane surface submerged in a static mass of liquid with usual notations. | 9 | L2 | CO2 |

**UNIT - III** **18**

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|---|---|---|---|---|
| 3 a. | Crude oil (SG = 0.85) flows upwards at a rate of 60 liters per second through a vertical venturimeter with an inlet diameter of 200 mm and a throat diameter of 100 mm. The coefficient of discharge of venturimeter is 0.98. The vertical distance between the pressure tapings is 300 mm. | 9 | L3 | CO3 |

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i) Determine the difference in the readings of pressure gauges connected to the inlet and throat section in kPa

ii) If a differential U-tube mercury oil monometer is used to connect the two tapings, determine the monometer readings sketch the arrangement

b. Draw simple sketches of the following flow measuring devices and write expressions for the flow parameters which they measure and explain the terms: i) Orifice meter ii) Pitot tube. 9 L2 CO3

c. Derive expression for continuity equations in three dimensions with usual rotations for an incompressible fluid. 9 L2 CO3

**UNIT - IV** **18**

4 a. A pipe as shown in Fig.Q4 (a) is used to connect two reservoirs carrying oil of specific gravity $S_o$. Explain in brief the various losses that occur during the flow of fluid (including both major and minor losses) with relevant equations; also express the difference in the heights of oil levels in the two reservoirs in terms of all the losses.

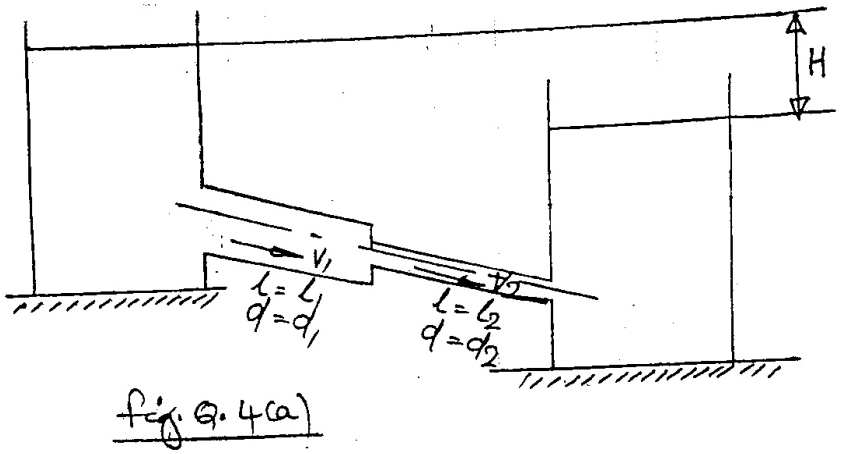


fig. Q. 4(a)

9 L3 CO4

b. Explain the following with reasons; draw appropriate sketches wherever applicable to substantiate your answer.

i) The casing of reactions turbines is spiral in shape in which area of cross sections gradually decreases

ii) Draft tube used in reactions turbines is a tube of gradually increasing cross sectional area.

iii) The buckets of a pelton wheel is double hemispherical in shape with a splitter at the center

9 L2 CO4

c. Draw velocity triangles at inlet and outlet for a pelton wheel turbine taking, i) $\beta = 90°$ and ii) $\beta$ as an obtuse angle. Write expressions for work done per second per unit weight of water striking the runner for both the cases and explain the terms. 9 L2 CO4

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**UNIT - V** **18**

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|---|---|---|---|---|
| 5 a. | Obtain an expression for the work done by the impeller of a centrifugal pump on water per second per unit weight of water by drawing velocity triangles at inlet and outlet. | 9 | L2 | CO5 |
| b. | Briefly explain the functions of the following by drawing appropriate sketches wherever applicable;<br>i) Air vessels of a reciprocating pump<br>ii) The spiral casing of a centrifugal pump<br>iii) Foot value and strainer placed at the end of suction pipe | 9 | L2 | CO5 |
| c. | A double acting reciprocating pump running at 50 rpm is discharging 900 liters of water per minute. The pump has a stroke of 400 mm. The diameter of the piston is 250 mm. The delivery and suction heads are 25 m and 4 m respectively. Find the slip of the pump and the power required to drive the pump. | 9 | L3 | CO5 |

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