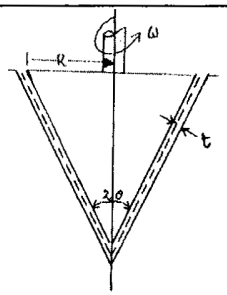
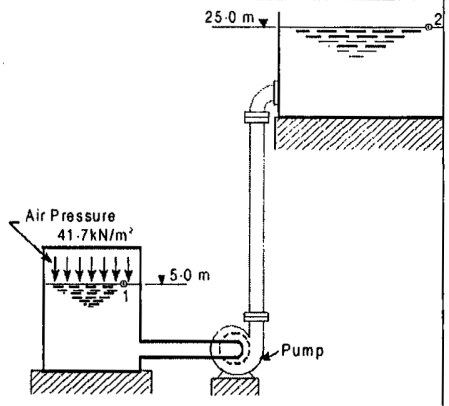
**Ex/PE/PC/B/T/214/2025**

*B.E. POWER ENGG. 2ND YEAR 1st SEMESTAR EXAMINATION, 2025*

*SUBJECT:* ***Fluid Mechanics***

**Time -3 hours** **Full Marks 100**

| | **CO1 (20 Marks)** | **Marks** |
|---|---|---|
| 1.(a) | How viscosity of a fluid varies with temperature?<br>Why better cleaning of dirty cloths hot water and detergent are required? | 4<br>2 |
| (b) | A conical thrust bearing idealized as cone of vertex angle $2\theta$, maximum cone radius $R$ rests and revolves over a uniform fluid layer of thickness '$t$' at a constant velocity $\omega$. For a fluid of dynamic viscosity $\mu$, determine the power utilized to overcome the viscous resistance.<br>  <br> | 10 |
| (c) | Define co-efficient of volume expansion coefficient. If the pressure of a liquid is increased from 75 bar to 140 bar, the volume of the liquid decreases by 0.147 per cent. Determine the bulk modulus of elasticity of the liquid.<br>OR<br>What should be the diameter of a droplet of water, if the pressure inside is to be 0.0018 bar greater than the outside? Given the value of surface tension of water in contact with air at 20°C as 0.075 N/m.. | 2+2<br><br><br>4 |
| | **CO2 (24 Marks)** | |
| 2 (a) | A flow field is given by $\vec{V} = (y^2 + z^2)\hat{\imath} + (x^2 + z^2)\hat{\jmath} + (x^2 + y^2))\hat{k}$ m/s. Find the velocity and acceleration of a fluid particle at point (1,2,3). Check whether the flow is rotational or irrotatioal? | 10 |
| (b) | An industry is required to discharge oil of specific gravity 0.85 at a rate of 86 liters per second to the overhead tank as shown in Fig. Losses in the whole system are 1.75 m of flowing fluid. Being an engineer a pump of how much power will suggest to your customer? (assume pump efficiency as 80%)<br>  <br> | 8 |
| (c) | Derive the equation of continuity in three-dimensional Cartesian coordinate system. | 6 |
| OR (c) | What do you mean by major loss and minor loss in a pipe flow? How to determine major loss when a fluid is flowing through a pipe (flow may be laminar or turbulent)? | 2+4 |
| | **CO3 (22 marks)** | |
| 3(a) | With a neat sketch of a venturimeter, deduce the expression of obtaining the flow rate of a fluid through a pipe.<br>OR<br>Find the discharge of water flowing through a pipe of 30 cm diameter placed in an inclined position where a venturimeter of throat diameter 15 cm has been inserted. The difference of pressure between the main and the throat is measured by a liquid of sp gr. 0.6 in an inverted U-tube, which gives a reading of 30cm. The loss in head is 0.2 times the kinetic head of the pipe. Find flow rate through the pipe. | 8 |

[ Turn over

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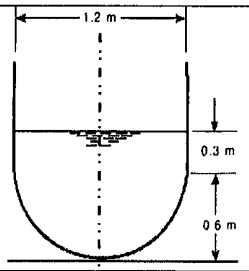
| | | | |
|---|---|---|---|
| 3(b) | A channel has vertical walls 1.2 m apart and a semicircular invert. If the centerline depth is 0.9 m and the bed slope is 1 in 2500, find the discharge using Chezy's formula with C = 54 $m^{1/2}/s$. |  | 6 |
| (c) | With a neat sketch show Mach angle, Mach line, Mach cone zone of silence and zone of disturbance for a supersonic flow. Write the relation between Mach number and Mach angle.<br>The wave formed by a missile moving in air gave a Mach angle of 35°. Find the speed of the missile if the pressure and density of air at that altitude are 30 kPa and 0.45 $kg/m^3$ respectively. | | 4<br>4 |
| | **CO4 (18 marks)** | | |
| 4 (a) | State two main purpose of Dimensional analysis.<br>Using Buckingham's $\pi$ theorem show that the thrust developed (T) by a propeller is .<br>$T = \rho D^2 V^2 f\left(\mathrm{Re}, Ma, D\omega/V\right)$<br>Where, $T$ depend on the angular velocity $\omega$, speed of advance $V$, diameter $D$, dynamic viscosity $\mu$, mass density of the fluid $\rho$ and elasticity of the fluid medium which can be represented by the speed of the sound $a$. | | 2<br>10 |
| (b) | A 1:10 scale model of a submarine moving far below the surface of water is tested in a water tunnel. If the speed of the prototype is 8 m/s, determine the corresponding velocity of water in the tunnel. Also determine the ratio of the drag for the model and the prototype. $\upsilon_{sea\ water} = 1.121 \times 10^{-6}\ m^2/s$; $\upsilon_{water} = 1.00 \times 10^{-6}\ m^2/s$; $\rho_{sea\ water} = 1027\ kg/m^3$; $\rho_{water} = 1000\ kg/m^3$. | | 6 |
| | **CO5 (16 marks)** | | |
| 5 (a) | A three stage centrifugal pump has 32 cm diameter impellers with 1.6 cm width at outlet. The velocity at the inlet is radial. The vanes are curved back at angle of 25° to the tangent at the outlet and occupy 10% of outlet area while running at 980 rpm. The pump delivers 45 liters of water per second with 90% manometric efficiency and 75% overall efficiency. **Calculate** the head generated by the pump and input power.<br>OR<br>A centrifugal pump has the following characteristics: outer diameter of impeller = 800 mm; width of impeller vanes at outlet = 100 mm; angle of impeller vanes at outlet = 40°. The impeller runs at 550 .r.p.m and delivers 0.98 cubic meters of water per second under an effective head of 35 m. A 500 kW motor is used to drive the pump. Determine the manometric efficiency of the pump. Assume water enters the impeller vanes radially at inlet. | | 8 |
| (b) | A jet of water is striking at the center of a curved plate with a velocity '$V$' while the plate is moving with velocity '$u$' in the direction of jet. With the help of a neat sketch, determine the maximum efficiency of the vane. Assume no friction.<br>OR<br>With a neat sketch of velocity vector diagram of a centrifugal impeller, deduce the expression of Euler Head. | | 8 |