*B.E. POWER ENGG. 2ND YEAR 1st SEMESTAR SUPPLEMENTARY EXAM- 2024*

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

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

| | **CO1 (20 Marks)** | **Marks** |
|---|---|---|
| 1.(a) | How viscosity of a fluid changes with temperature? Give reasons in each case | 6 |
| (b) | A square plate of 50 cm x 50 cm weighing 200N is allowed to slide down an inclined plane, which is laid at a slope of 1(one) vertical to 2.5 horizontal. What will be the terminal velocity of the plate if 0.02 mm thickness of oil film lies between the plane and the plate? | 10 |
| (c) | Determine the bulk modulus of a fluid that has a density increase of 0.002% for a pressure increase of 45 kN/m$^2$. | 4 |
| | **CO2 (24 Marks)** | |
| 2 (a) | A fluid field is given by $\vec{V} = (6 + xy + 2t)\hat{\imath} + 6x^3\hat{\jmath} + (3xt^2 - yz)\hat{k}$ m/s. Find the velocity and acceleration of a fluid particle at point (2, 1, -2) when $t$=2 sec. | 10 |
| (b) | A conical diffusing section diverges uniformly from 0.1 m diameter (fluid entry pt.) to 0.3 m diameter over 2m length. Find local and convective acceleration at a distance of 0.5 m from entry when flow rate is fixed at 50 *l*/s and | 8 |
| (c) | State Darcy-Weisbach equation. What is the purpose of the equation? | 6 |
| OR (c) | A right angled V-notch is employed to measure the discharge. Estimate the flow rate if the head ($H$±d$H$) measured above the still is given as (0.2±0.01) m. take $C_d$=0.60 | 2+4 |
| | **CO3 (22 marks)** | |
| 3 (a) | A trapezoidal channel requires discharging 6 m$^3$/s at a velocity of 1.5 m/s Find the most economic cross section if channel has a side slope of 1 vertical to 2 horizontal. Also find slope of the channel bed. $C$= 55 m$^{1/2}$/s. | 8 |
| (b) | With a neat sketch of a venturimeter, deduce the expression of obtaining the flow rate of a fluid through a pipe.<br>OR<br>A fluid of relative density 0.9 flows through a pipe of diameter 120 mm. The flow rate is measured using a 6 cm diameter orifice plate with corner tapings, which are connected to the two limbs of a differential U-tube manometer using mercury as the manometric fluid. The discharge coefficient is 0.60. Calculate the mass flow rate when the difference in the mercury levels in the U-tube is 100 mm. | 8 |
| (c) | A supersonic plane flies at 2200 km/hr at an altitude of 8 km above sea level in standard atmosphere. If the pressure and density of air at that altitude be 40 kPa and 0.5 kg/m$^3$, calculate the pressure, temperature and density at stagnation point at the nose of the plane. Take R=287 J/kg K, and $\gamma$=1.4. | 6 |
| | **CO4 (16 marks)** | |
| 4 (a) | State Buckingham's Pi-theorem.<br>A disc of diameter $D$ immersed in a fluid of density $\rho$ and viscosity $\mu$ has a constant rotational speed $\omega$. The power required to drive the disc is $P$. Show that $P = \rho\omega^3 D^5 \phi(\rho\omega D^2 / \mu)$. | 2+6 |
| (b) | A torpedo-shaped object 900 mm diameter is to move in air at 60 m/s and its drag is to be estimated from tests in water on a half-scale model. Determine the necessary speed of the model and the drag of the full-scale object if that of the model is 1140 N. (Dynamic viscosities: air 1.86 × 10$^{-5}$ Pa-s; water 1.01 × 10$^{-3}$ Pa-s. Densities: air 1.20 kg/m$^3$; water 1000 kg/m$^3$.) | 8 |

**Ex/PE/PC/B/T/214/2024(S)**

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

| | **CO5 (18 marks)** | |
|---|---|---|
| 5 (a) | A three stage centrifugal pump has 30 cm diameter impellers with 1.5 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 950 rpm. The pump delivers 42 liters of water per second with 90% manometric efficiency and 80% overall efficiency. **Calculate** the head generated by the pump and input power.<br>OR<br>A centrifugal pump is required to deliver 40 liter of water per second to an open tank at a height of 40 m through a 100m long pipe of 15 cm diameter. The inlet losses of head in the suction pipe are estimated to be 0.30 meter. Assuming overall efficiency of 75% **determine** the power required to drive the pump. Take $f$=0.2 for pipe. | 10 |
| (b) | A jet of water is striking at the center of a flat 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. What will be the maximum efficiency (jet striking at center) for series of semicircular vanes mounted on a wheel?<br>OR<br>With a neat sketch of velocity vector diagram of a centrifugal impeller, deduce the expression of Euler Head. | 8 |