Q.P.Code: 39964

(3 Hours) [Total Marks: 80]

Question no.1 is compulsory.
Attempt any three from question no. 2 to 6.
Use illustrative diagrams where ever possible.

Q1 Solve any 4 out of 5 questions

a Define the following : i) Mach number ii) Stagnation Pressure 5

b The velocity profile for laminar flow of water between two fixed parallel plates is given by $u=0.01[\ 1-1000\ y^2\ ]$ where u is in m/s and y is in m. The viscosity of water can be assumed to be 10^{-3} Ns/m^2 and the gap between the two plates is 2 cm. Calculate the shear stress on each plate. 5

c Prove that the Stream function and Velocity Potential functions are perpendicular to each other at all points of intersections. 5

d Define : i) Streamline bodies ii) Bluff bodies 5

e A door in a tank is in the form of a quadrant of a cylinder of 1.5m radius and 8m wide. Calculate the resultant force on the door and its location. 5

Q2 a The velocity profile within a laminar boundary layer over a flat plate is given by 10

$$\frac{u}{U} = \sin\left(\frac{\pi y}{2\delta}\right)$$

where U is the mean stream velocity and δ is the boundary layer thickness. Determine the i) Displacement thickness and ii) Momentum Thickness

b A two dimensional flow is described in Lagrangian system as 10

$x = x_0 e^{-tk} + y_0(1 - e^{-2tk})$ and $y = y_0 e^{tk}$

Find :

i) The equation of fluid particle in flow field

ii) The velocity components in Eulerian system

Q3 a A fluid is in laminar motion between two parallel plates separated by a distance 'b' under the action of one of the plates and also under the presence of a pressure gradient in such a way that the net forward discharge across any section is zero. Consider 'U' be the velocity of the moving plate : 10

i) Find the point where minimum velocity occurs and its magnitude.

ii) Draw a rough sketch of velocity distribution across any section.

b A flow has a velocity potential function given by $\emptyset = x^3 - 3xy^2$. Verify whether it represents valid flow field. If it does, then determine the stream function and also calculate the velocity and pressure at (1, -3) given that the pressure at (4, 1) is 14kPa and the fluid is water. 10

Q4 a The difference in water surface levels in two tanks, which are connected by 3 pipes in series of length 300m, 170m and 210m and of diameter 300m, 200m and 400m respectively, is 12m. Determine the rate of flow of water if co efficient of friction are 0.005, 0.0052 and 0.0048 respectively, considering minor losses only. 10

TURN OVER

	b	The pressure, velocity and temperature just upstream of a normal shock wave in air are 100 KPa (abs), 660 m/s, and -20°C respectively. Calculate the pressure, velocity and temperature just downstream of the shock wave [Take ratio of specific heats k = 1.4 and gas constant R= 287 J/(Kg K)]	10
Q5	a	The velocity distribution in a pipeline is prescribed by the relation $u = 2y-y^2$ where u denotes the velocity of a layer at a large distance from the solid boundary. Calculate i) Shear stress at the wall ii) Shear stress at 0.5cm from the wall. iii) Total resistance for 2cm diameter pipe over a length of 100m. Assume co efficient of viscosity as 0.4 Poise	10
	b	Starting from Navier-Stokes equation for incompressible fluid and laminar flow, derive the equation for velocity profile for Couette flow. State the assumptions made.	10
Q6	a	An oil of dynamic viscosity 1.5 Poise and relative density 0.9 flows through a 3cm diameter vertical pipe. Two pressure gauges are fixed 20m apart. The gauge A fixed at the top records 200kPa and the gauge B fixed at the bottom records 500kPa. Find the direction of flow and the rate of flow.	10
	b	Write short notes on : i) Pitot tube ii) Phenomenon of wave propagation in compressible fluid flow.s	5