[3 Hours] **[Marks: 80]**

N.B Question no.1 is compulsory.
Attempt any **THREE** from question no.2 to 6.
Use illustrative diagrams wherever possible.

Q.1 Attempt any four from the following. Each question carry equal marks. 20

a) Explain conditions of equilibrium of floating bodies

b) Explain i) velocity potential function ii) stream function

c) Do the following velocity component represent physically possible flow?

$u = x^2y$; $v = 2zy - xy^2$; $w = x^2 - z^2y$

d) An aircraft is flying with a velocity of 200 m/s through the still air at – 15°C. Find the stagnation pressure, if the mass density of the air is 1.08 kg/m^3. Take pressure of the air as 80 kPa. Take R = 287 J/kgK .

e) Explain surface tension and capillarity

Q.2 10

a) A heavy car plunges into a lake during an accident and lands at the bottom of the lake on its wheels. The door is 1.2 m high and 1 m wide, the top edge of the door is 8 m below the free surface of the water. Determine the hydrostatic force acting on the door approximating it as a vertical rectangular plate and the location of centre of pressure considering bottom of the lake surface as horizontal.

b) What is Venturimeter? Derive expression of the discharge through venturimeter. 10

Q.3 10

a) A 45° reducing bend is connected in a pipe line, the diameter at the inlet and outlet of the bend being 400 mm and 200 mm respectively. Find the force exerted by water on the bend if the intensity of pressure at inlet of bend is 215.8KN/m^2. The rate of flow of water is 500 lit/sec.

10

b) A fluid of viscosity 8 poise and specific gravity 1.2 is flowing through a circular pipe of diameter 100 mm. The maximum shear stress at the pipe wall is 210 N/m^2. Find i) The pressure gradient ii) The average velocity iii) Reynolds number of flow.

Q.4 10

a) Two reservoirs with a difference in elevation of 15 m are connected by two pipes in series. The pipes are 150 m long of 20 cm diameter and 200 m long of 25 cm diameter respectively. The friction factors for the two pipes are respectively 0.020 and 0.019. Determine discharge through pipe considering both major and minor losses. 07

b) What do you meant by boundary layer separation? What is the effect of pressure gradient on boundary layer separation?

c) Define Mach number and give its significance. 03

Q.5

a) Describe compressible flow through a convergent- divergent nozzle. 07

b) What do you understand by displacement thickness and momentum thickness? 08
Determine displacement thickness and momentum thickness for the following velocity distribution.

$$\frac{u}{Uo} = \frac{3}{2}\left(\frac{y}{\delta}\right)$$

05

c) A flow field is characterised by $\psi = x^3y$. Determine the velocity potential function ϕ for the flow if the flow is irrotational.

Q.6 05

a) An aeroplane is flying at a height of 20 km, where the temperature is – 40°C. The speed of the plane is corresponding to M = 1.8. Assuming k = 1.4 and R = 287 J/kgK. Find the speed of the plane.

b) Explain streamlined body and bluff body. 05

c) State and prove Bernoulli's theorem for streamline flow. 10
