# B.Tech. Degree III Semester Examination, November 2008

## ME 304 FLUID MECHANICS

*(2006 Scheme)*

Time: 3 Hours Maximum Marks: 100

**PART A**

(Answer ***ALL*** questions)

(All questions carry ***FIVE*** marks)

(8 x 5 = 40)

I a) Prove that the centre of pressure always lies below the centre of gravity on a flat plate immersed in a liquid at some angle to the free surface.

b) Explain potential flow? Derive from first principles, the condition for irrotational flow.

c) An aeroplane is designed to have a maximum speed of 750 kmph. If the specific weight of air is 12 N/m$^3$, determine the maximum length of a mercury manometer to be connected to the pitot static tube installed in it.

d) Explain the minor losses occurring in fluid flows.

e) Define Doublet and vortex pair.

f) Derive the relationship between velocity potential and stream function. Also deduce the Laplace equations for these two.

g) Write notes on (i) Vortex sheet ii) Vortex filament.

h) When do boundary layers separate from a body surface? Explain how stream lining reduces the form drag on a body?

**PART B**

(4 x 15 = 60)

II a) A circular lamina of radius R is kept immersed in a liquid such that it's top most point A is on the free surface. Determine the depth and width of the horizontal chord BC so that the total thrust due to hydrostatic pressure on the triangle ABC is maximum. (8)

b) A triangular plate of 1 metre base and 1.5 metre attitude is immersed in water. The plane of the plate is inclined at 30$^0$ with free water surface and the base is parallel to and at a depth of 2 meters from water surface. Find the total pressure on the plate and position of centre of pressure. (7)

**OR**

III Show that a cylindrical body 1.25 m diameter and 3.25m height weighing 11127 N will not float vertically in sea water weighing 10055 N/m$^3$ . Fluid the tension necessary in a vertical chain attached to the centre of the base of the body that will just keep the cylinder vertical. (15)

IV a) A notch is in the form of a circle of radius R. Find an equation for the discharge through the notch when the head causing flow is H $(\langle R)$ (6)

b) Three pipes 300 m long, 30cm diameter; 150m long, 20cm diameter; and 200m long and 25cm diameter are connected in series between two reservoirs. The friction factor values for the three pipes are 0.018, 0.020 and 0.019 respectively. Determine the rate of flow, if the difference in elevations of water levels between two reservoirs is 15 m. Account for all the losses. Draw the total energy line for the flow. Contraction and expansions are sudden. (9)

**OR**



***(Turn over)***

V a) Prove that the velocity distribution in laminar flow through a circular pipe is parabolic and hence deduce that the average velocity is half the maximum velocity. (6)

b) A venturimeter is installed in a pipeline carrying water and is 30cm in diameter. The throat diameter is 12.5cm. The pressure in pipeline is 140 kN/m$^2$, and the vacuum in the throat is 37.5 cm. of Mercury. Four percent of the differential head is lost between the gauges. Working from first principles find the flow rate in the pipeline in L/S, assuming the venturimeter to be horizontal. (9)

VI a) A conical pipe 10cm inlet diameter, 20cm outlet diameter and 100 cm. long is placed horizontally. The velocity over any cross section may be considered to be uniform. Determine the convective and local accelerations at a section where the diameter is 15 cm. for the following cases:

i) Constant inlet discharge 0.2cm$^3$/sec.

ii) Inlet discharge varying linearly from 0.2m$^3$/sec. to 0.4m$^3$/sec. over two seconds. The time of intersect is when t = 1 second. Comment on the assumption of uniform flow over any cross section in the light of the continuity equation. (9)

b) Derive an equation for stream function and velocity potential function for a uniform stream of velocity V in a two dimensional field, the velocity being inclined to the X-axis an angle $\alpha$. (6)

**OR**

VII a) A uniform flow with a velocity 2m/sec. is flowing over a source placed at the origin. The stagnation point occurs at (-0.398,0). Determine:

i) Strength of source

ii) Maximum width of Rankine half body.

iii) Other principal dimensional of the Rankine half body. (9)

b) In a 2D flow the stream function is given by $\psi = 2xy$. Calculate the velocity at a point (3, 6). Show that the velocity potential $\phi$ exists for this case and deduce it. Also draw the streamlines corresponding to $\psi = 100$ and $\psi = 300$ (6)

VIII The velocity distribution is a laminar boundary layer is given by

$$\frac{u}{U} = 2\left(\frac{y}{\delta}\right) - 2\left(\frac{y}{\delta}\right)^3 + \left(\frac{y}{\delta}\right)^4$$ in which u = velocity at y, U = free stream velocity.

Obtain an expression for boundary layer thickness, shear stress, drag force on one side of the plate and co-efficient of drag in terms of Reynold's number. (15)

**OR**

IX a) Explain flow visualization techniques. (8)

b) Air flows over a flat plate 1m. long at a velocity of 6m/s. Determine:

a) the boundary layer thickness at the end of the plate.

b) shear stress at the middle of the plate.

c) total drag per unit length on the sides of the plate.

Take $\rho$ = 1.226 Kg/m$^3$ and $\nu = 0.15 \times 10^{-4}\ m^2/s$ for air. (7)

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