ET-201(A)

B.Tech. Civil (Construction Management) / B.Tech. Civil (Water Resources Engineering) B.Tech. (Aerospace Engineering)

Term-End Examination

01812

June, 2013

ET-201(A) : MECHANICS OF FLUIDS

Time : 3 hours *Maximum Marks : 70*

Note : *Attempt **any seven** questions. All questions carry **equal marks**. Use of calculator is permitted.*

1. (a) A liquid compressed in a cylinder has a volume of 0.0113 m^3 at $6.87 \times 10^6 \ N/m^2$ pressure and a volume of 0.0112 m^3 at $13.73 \times 10^6 \ N/m^2$ pressure. What is its bulk modulus of elasticity ? 5+5

(b) If the equation of a velocity distribution over a plate is given by

$v = 2y - y^2$,

in which v is the velocity in m/s at a distance y, measured in metres above the plate, what is the velocity gradient at the boundary and at 7.5 cm and 15 cm from it ? Also determine the shear stress at these points if viscosity $\mu = 8.60$ poise.

2. (a) When 2500 litres of water flows per minutes through a 0.3 m diameter pipe which later reduces to a 0.15 m diameter pipe, calculate the velocities of flow in the two pipes. **5+5**

(b) The velocity components in a two dimensional flow field for an incompressible fluid are expressed as

$$u = \frac{y^3}{3} + 2x - x^2 y,$$

$$v = xy^2 - 2y - \frac{x^3}{3}$$

(i) Show that these functions represent a possible case of an irrotational flow,

(ii) Obtain an expression for stream function ψ.

3. (a) A stream function is given by **5+5**

$\psi = 3x^3 - y^3$

Determine the magnitude of velocity components at the point (2,1).

(b) A stream function in a two - dimensional flow is :

$\psi = 2xy$

Show that the flow is irrotational and determine the corresponding velocity potential ϕ·

4. (a) Calculate the velocity components u and v for the following velocity potential function : 5+5

$\phi = x + y$

Is this velocity potential function satisfy the continuity equation ?

(b) The velocity components in the x and y direction are given as

$$u = \left(\frac{2xy^3}{3}\right) - x^2y, \text{ and}$$

$$v = xy^2 - \left(\frac{2yx^3}{3}\right).$$

Indicate whether the given velocity distribution is a possible field of flow or not.

5. (a) A 0.25 m diameter pipe carriers oil of specific gravity 0.8 at the rate of 120 litres per second and the pressure at a point A is 19.62 KN/m^2 (gauge). If the point A is 3.5 m above the detum line, calculate the total energy at a point A in metres of oil. 5+5

(b) A venturi meter is to be fitted in a pipe 0.25 m diameter where the pressure head is 7.6 m of flowing liquid and the maximum flow is 8.1 m^3 per minute. Find the least diameter of the throat to ensure that the pressure head does not become negative. Take $C_d = 0.96$ where C_d is coefficient of discharge.

6. (a) State and Derive Bernovlli's theorem, mentioning clearly the assumptions underlying it. 5+5

(b) A jet of water issues from a sharp edged vertical orifice under a constant head of 0.51 m. At a certain point of issuing jet, the horizontal and vertical co-ordinates measured from the veha- contracta are 0.406 m and 0.085 m respectively. Derive C_v, if C_d =0.62, Also find C_c.

7. (a) Obtain the condition for maximum efficiency in transmission of power through a pipeline. 5+5

(b) For the following types of velocity distribution obtain the values of $\frac{\delta^*}{\delta}$ and $\frac{\theta}{\delta}$

when $\frac{u}{\mathrm{u}} = 2\frac{y}{\delta} - \left(\frac{y}{\delta}\right)^2$

Here δ^* = displacement thickness and

θ = momentum thickness

8. (a) Explain the characteristics of laminar and turbulent boundary layer. 5+5

(b) For laminar flow of an oil having dynamic viscosity μ = 1.766 Pa S in a 0.3 m diameter pipe, the velocity distribution is parabolic with a maximum velocity of 3 m/s at the centre of the pipe. Calculate the shearing stresses at the pipe wall and within the fluid 50 mm from the pipe wall.

9. (a) What do you understand by hydrodynamically smooth and rough pipes ? 5+5

(b) A circular disc 3 m in diameter is held normal to a 26.4 m/s wind of density 1.2 kg/m^3. What force is required to hold it at rest ? Assume coefficient of drag of disc as 1.1.

10. (a) The pressure drop 'Δp' in a pipe of diameter D and length l depends on mass density ρ and viscosity μ of the flowing fluid, mean velocity of flow V and average height k of roughness projections on the pipe surface. Obtain a dimensionless expression for Δp. Hence show that 5+5

$$h_f = \frac{flV^2}{2gD}$$

where h_f is the head loss due to friction $\left(=\frac{\Delta p}{w}\right)$, where w is the specific weight of the fluid and f is coefficient of friction.

(b) A cylinder has a diameter 0.3m and a specific gravity of 0.75. What is the maximum permissible length in order that it may float in water with its axis vertical ?
