Printed Pages : 4

NCE-301

(Following Paper ID and Roll No. to be filled in your Answer Book)

PAPER ID : 100311

Roll No.

B. Tech.

(SEM. III) (ODD SEM.) THEORY EXAMINATION, 2014-15

FLUID MECHANICS

Time : 3 Hours] [Total Marks : 100

Note : (i) Attempt all questions.

(ii) Assume suitable data if not given in the numerical question.

(iii) Draw neat sketches wherever required.

1. Answer any four parts of the following : $5 \times 4 = 20$

a. A square plate 50cm x 50cm weighing 200 N slides down an inclined plane of slope 1 vertical: 2.5 horizontal with a uniform velocity of 0.40 m/s. if a thin layer of oil of thickness 0.5 cm fills the space between the plate and the inclined plane determine the coefficient of viscosity of oil.

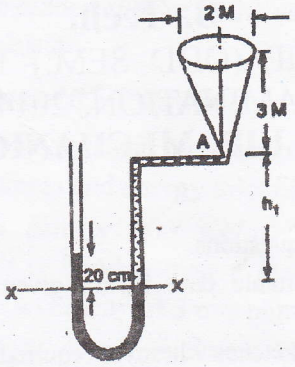
b. Draw and explain Rheological diagram.

c. An oil of viscosity 5 poise is used for lubrication between a shaft and sleeve. The diameter of the shaft is 0.5 m and it rotates at 200 rpm. Calculate the power lost in oil for the sleeve length of 100mm. the thickness of the oil film is 1 mm.

d. With the neat sketches, explain the conditions of equilibrium for floating and submerged bodies.

e. A tank contains water upto a height of 0.5 m above the base. An immiscible liquid of specific gravity 0.8 is filled on the top of water upto 1 m height. Calculate total pressure on one side of tank and the position of Centre of Pressure for one side of the tank which is 2 m wide.

f. Figure shows a conical vessel having its outlet at A to which a U- tube manometer is connected. The reading of the manometer given in the figure shows when the vessel is empty. Find the reading of the manometer when vessel is completely filled with water.



2. Answer any **four parts** of the following : $5 \times 4 = 20$

a. For steady incompressible flows derive the continuity equation using 3-D rectangular co-ordinate system.

b. Sketch the stream lines represented by $\Psi = x^2 + y^2$. Also find out the velocity and its direction at point (1,2).

c. What is flow net ? Describe any one method of drawing flow net.

d. If for a 2-D potential flow, the velocity potential is given by $\phi = x(2y-1)$. Determine the velocity at the point P (4, 5). Determine also the value of stream function at the point P.

e. A jet of water from a 25mm diameter nozzle is directed vertically upwards. Assuming that the jet remains circular and neglecting any loss of energy, what will be the diameter at a point 4.5m above the nozzle, if the velocity with which the jet leaves the nozzle is 12m/s.

f. Write short note on:

(i) Subcritical, critical and supercritical flow

(ii) Subsonic, sonic and supersonic flow

(iii) Laminar and turbulent flow.

3. Answer any **two parts** of the following : **10 × 2 = 20**

a. In a vertical conveying oil of specific gravity 0.8, two pressure gauges have been installed at A and B where the diameters are 16 cm and 8 cm respectively. A is 2 m above B. The pressure gauge readings have shown that the pressure at B is greater than at A by 0.981 N/cm^2. Neglecting all losses, calculate the flow rate. If the gauges at A and B are replaced by tubes filled with the same liquid and connected to a U- tube containing mercury. Calculate the difference of level of mercury in the two limbs of U-tube.

b. In a 45° bend a rectangular air duct of 1 m^2 cross-sectional area is gradually reduces to 0.5 m^2 area. Find the magnitude and direction of the force required to hold the duct in position if the velocity of flow at the 1 m^2 section is 10m/s and pressure is 2.943 N/cm^2. Take density of air as 1.16 Kg/m^3.

c. Using Buckingham's π theorem, show that the discharge Q consumed by an oil ring is given by

$$Q = (Nd^3)\, f\,[\mu/(\rho N d^2), \sigma/(\rho N^2 d^3), \omega/(\rho N^2 d)\,]$$

Where **d** is internal diameter of ring, **N** is rotational speed, **ρ** is density, **μ** is viscosity, **σ** is surface tension and **ω** is the specific weight of oil.

4. Answer any **two parts** of the following : **10 × 2 = 20**

a. Derive the equation of motion for laminar flow through pipes. Also derive the expression for velocity and shear stress distribution across the pipe with neat sketches.

b. Prove that the difference of local velocity **u** and average velocity **U** for turbulent flow through smooth or rough pipe is given by:

$$(u - U)/u = 5.75 \log_{10}(y/R) + 3.75$$

c. (i) A pipe of diameter 300mm and length 3500m is used for the transmission of power by water. The total head at the inlet of the pipe is 500m. Find the maximum power available at the outlet, if the value of $f = 0.006$.

(ii) What do you understand by water hammer? Derive an expression for sudden closure of the valve considering pipe material is elastic.

5. Answer any **two parts** of the following : $10 \times 2 = 20$

a. (i) What do you understand by momentum thickness, displacement thickness and energy thickness?

(ii) An oil with density 900 Kg/m^3 and kinematic viscosity 10^{-5} m^2/s is flowing over a plate of 3 m long and 2 m wide with a velocity of 3 m/s parallel to 3m side. Find the boundary layer thickness at the point of transition and at the end of the plate.

b. (i) A kite 60cm x 60cm in size weighing 3N makes an angle of 10° with horizontal. The thread attached to it makes an angle of 45° to the horizontal and pull on the string is 25 N. The wind is flowing over the kite at 15 m/s. Find C_L and C_D for kite.

(ii) What do you understand by coefficient of lift, coefficient of drag and aerofoil?

c. (i) Explain the phenomenon of drag on a sphere and define Stroke's law. Draw a graph between C_D and various values of Reynolds number.

(ii) Discuss the effect of pressure gradient on boundary layer separation with neat sketches.