Name : .....

Roll No. : .....

Invigilator's Signature : .....

CS/B.Tech (ME/AUE/PWE/PE-NEW)/SEM-4/ME-401/2013

2013

FLUID MECHANICS & HYDRAULIC MACHINES

Time Allotted : 3 Hours *Full Marks :* 70

The figures in the margin indicate full marks.

Candidates are required to give their answers in their own words as far as practicable.

Missing data, if any, are to be assumed reasonably.

GROUP – A

(Multiple Choice Type Questions)

1. Choose the correct alternatives for any *ten* of the following : 10 × 1 = 10

   i) Absolute pressure is defined as

      a) Gauge pressure + Atmospheric pressure

      b) Gauge pressure – Atmospheric pressure

      c) Gauge pressure × Atmospheric pressure

      d) Gauge pressure ÷ Atmospheric pressure.

   ii) Pitot tube is used to measure

      a) dynamic viscosity b) kinematic viscosity

      c) mass density d) velocity of flow.

iii) In Darcy-Weisbach equation the major head loss for pipe of friction factor f is given by

a) $h_f = \frac{f l V^2}{2D}$ b) $h_f = \frac{f l V^2}{2g}$

c) $h_f = \frac{f V^2}{2gD}$ d) $h_f = \frac{f l V^2}{2gD}$.

iv) Newton's law of viscosity relates

a) pressure, velocity and viscosity

b) shear stress and rate of angular deformation in fluids

c) shear stress, temperature, viscosity and velocity

d) pressure viscosity and rate of angular deformation.

v) The separation of boundary layer occurs when

a) the flow is accelerated past the boundary

b) the boundary layer comes to rest

c) any adverse pressure is encountered

d) the fluid is ideal.

vi) The nominal thickness of boundary layer represents the distance from the surface to a point where

a) flow ceases to be laminar

b) the shear stress becomes maximum

c) velocity is 99 per cent of its asymptotic limit

d) the flow behaves as if it were rotational.

vii) For stable equilibrium of floating bodies, the centre of gravity has to be

a) always below the centre of buoyancy

b) always above the centre of buoyancy

c) always above the metacentre

d) always below the metacentre.

viii) Air vessel in reciprocating pump is used

a) to obtain a continuous supply of water at uniform rate

b) to reduce suction head

c) to increase delivery head

d) none of these.

ix) For low head and high discharge the suitable turbine is

a) Francis b) Kaplan

c) Pelton d) None of these.

x) $(\text{Froude no})^2$ is defined as

a) $\frac{\text{Inertia force}}{\text{Viscous force}}$ b) $\frac{\text{Inertia force}}{\text{Gravity force}}$

c) $\frac{\text{Inertia force}}{\text{Elastic force}}$ d) $\frac{\text{Inertia force}}{\text{Pressure force}}$.

xi) Draft tube is used to increase

a) head of turbine

b) to collect waste water of turbine

c) efficiency & power output of turbine

d) none of these.

xii) If φ is the potential function in two-dimensional flow field, then the velocity components u and v are defined as

a) $u = \frac{\delta \varphi}{\delta x}$ and $v = \frac{\delta \varphi}{\delta y}$

b) $u = -\frac{\delta \varphi}{\delta y}$ and $v = \frac{\delta \varphi}{\delta x}$.

xiii) The hydrostatic pressure in a liquid at rest

a) remains constant only on a vertical plane

b) increases linearly with depth below a free surface

c) remains constant at all points in the fluid

d) decreases linearly with depth below a free surface.

GROUP – B

(Short Answer Type Questions)

Answer any *three* of the following. $3 \times 5 = 15$

2. Derive euler's equation of motion along a streamline for an ideal fluid. Explain how this is integrated to get Bernoulli's equation along a streamline.

3. a) For a 2-D potential flow the potential is given as $\phi = x(2y - 1)$. Determine the velocity at point P (4, 5).

b) Write short notes on Hydraulic gradient line and Total energy line. 2 + 3

4. Water is flowing in a stream which may be assumed rectangular with width 10 cm and depth of water 1 m. The bed of the channel slopes at 1 in 2000 and this is constant for at least 2 km upstream. Taking Chezy constant $C = 60\ m^{1/2}/s$, calculate the steady flow in the channel. A dam is placed across the channel, increasing the depth at the dam to 2 m.

5. a) Write short note on characteristic curve of a centrifugal pump.

   b) What do you mean by NPSH ? 3 + 2

6. a) Distinguish between the pressure drag and friction drag.

   b) Experiments were conducted in a wind tunnel with a wind speed of 50 km/hr, on a flat plate of size 2 m long and 1 m wide. The density of air is $1{\cdot}15\ k/m^3$. The plate is kept at such an angle that the coefficients of lift and drag are 0·75 and 0·15 respectively. Determine the

      i) Lift force

      ii) Drag force

      iii) Resultant force exerted by the air stream on the plate. 2 + 3

7. The volume flow rate Q and the pressure p developed by the rotary are dependent on the fan impeller diameter D, speed N, fluid density ρ and viscosity μ. Derive the expression for the non-dimensional parameters governing the fan performance.

GROUP – C

(Long Answer Type Questions)

Answer any *three* of the following. 3 × 15 = 45

8. a) Draw the velocity diagram and derive the work done of a pelton wheel. 5

b) Show that the maximum efficiency of the Pelton wheel $\eta h_{max} = \frac{(1 + \cos \phi)}{2}$, where ϕ = vane angle at outlet. 3

c) The following data is related to a pelton wheel. 7

Head at the base of the nozzle	—	80 m
Diameter of the jet	—	100 mm
Discharge of the nozzle	—	0·30 m^3/s
Power at the shaft	—	206 kW
Power absorbed in mechanical resistance	—	4·5 kW

Determine :

i) Power loss in nozzle

ii) Power loss due hydraulic resistance in the runner.

9. a) A centrifugal pump running at 900 rpm is working against a head of 16 m. The external diameter of the impeller is 360 mm and the outlet width is 40 mm. If the vane angle at outlet is 30° and the manometric efficiency is 80%, find the discharge of the pump.

   b) A double acting reciprocating pump running at 40 rpm is discharging 1·0 m^3 of water per minute. The pump has a stroke length of 400 mm. The diameter of the piston is 200 mm. The delivery and suction heads are 20 m and 5 m respectively. Find the slip of the pump and power required to drive the pump. 9 + 6

10. Three pipes of 400 mm, 200 mm and 300 mm diameters have lengths of 400 m, 200 m and 300 m respectively. They are connected in series to make a compound pipe. The ends of this pipe are connected with two tanks whose difference of water level is 16 m. Determine the discharge through the compound pipe neglecting first the minor losses and then including them. (f = 0·02)

11. a) A cylindrical shaft of 90 mm diameter rotates about a vertical axis inside a fixed cylindrical tube of length 500 mm and internal diameter 95 mm. If the space between the tube and the shaft is filled by a lubricant of viscosity 0·2 Pa-s, determine the power required to overcome viscous resistance, when the shaft rotates at 240 rpm. 7

    b) A rectangular plane, 1·2 m × 1·8 m is submerged in water and makes an angle of 30° with the horizontal, the 1·2 m sides being horizontal. Calculate the magnitude of the force on one face and the position of the centre of pressure when the top edge of the plane is

       i) at the water surface

       ii) 500 mm below the water surface. 8

12. a) For the velocity profile for laminar boundary layer.

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

Obtain an expression for boundary layer and momentum the thickness.

b) A 30 cm × 15 cm venturimeter is provided in a vertical pipeline carrying oil of specific gravity 0·9, the flow being upwards. The difference in elevations of the throat section and entrance section of the venturimeter is 30 cm. The differential *U*-tube mercury manometer shows a gauge, deflection of 25 cm. Calculate

i) the discharge of the oil, and

ii) the pressure difference between the entrance and throat section.

Take the discharge coefficient as 0·98 and the specific gravity of mercury as 13·6.

c) Sketch different types of draft tubes with their functions. 6 + 9

13. Write short notes on any *three* of the following : 3 × 5

a) Cavitation

b) Stability floating object

c) Temperature effect on viscosity of fluids

d) Minor losses

e) Specific speed.