Roll No. : _____

4E2034

Total Printed Pages : **4**

B. Tech. (Sem. IV) (Main/Back) Examination, June/July - 2011
Civil Engineering
4CE3 Hydraulics & Hydraulic Machines

Time : **3** Hours]

[Total Marks : **80**
[Min. Passing Marks : **24**

*Attempt any **five** questions, selecting **one** question from each unit. **All** questions carry **equal** marks. Schematic diagrams must be shown wherever necessary. Any data you feel missing suitably be assumed and stated clearly.*
Units of quantities used/calculated must be stated clearly.

Use of following supporting material is permitted during examination.
(Mentioned in form No. 205)

1._____Nil_____   2._____Nil_____

UNIT-I

1 (a) What do you understand by hydraulic similitude ? State the condition for perfect similitude.

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(b) A ship has a length of 150 m and wetted area of 3000 m^2. A model of this ship 5m in length when towed in fresh water at 2m/s produces a resistance of 39.24N. The ship surface has skin resistance of 49.05 N/m^2 at a velocity of 3 m/s and the velocity index is 1.85. The corresponding values for the model surface towed in fresh water are respectively 16.38 N/m^2, 3m/s and 1.90.
Calculate :
(i) the corresponding speed of ship
(ii) the shaft power required to propel the ship at this speed through sea water (ρ =1030 kg/m^3). Take the propeller efficiency as 75%.

8

OR

1 (a) (i) How would you ascertain that a superfluous variable had been wrongly taken in dimensional analysis ?

$1\frac{1}{2}$

(ii) How would you know that a pertinent variable had been omitted in dimensional analysis ?

$$1\frac{1}{2}$$

(iii) State limitations and uses of dimensional analysis.

$$2\frac{1}{2}$$

(iv) Compare Rayleigh's method and Buckingham's π-theorem.

$$2\frac{1}{2}$$

(b) The drop in pressure 'Δp' due to an obstruction in a pipe depends on the pipe diameter 'D', the mean velocity 'V', mass density 'ρ' and viscosity of fluid 'μ'

Show that $\dfrac{\Delta \rho}{\rho V^2} = \phi \left[\left(\dfrac{d}{D} \right), \left(\dfrac{\rho DV}{\mu} \right) \right]$

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UNIT-II

2 (a) Show that for laminar flow in pipes

$$\frac{\tau_o}{eV^2} = \frac{F}{8}$$

where τ_o is the shear stress at walls, ρ is mass density, V is mean velocity of flow and f is Darcy's friction coefficient.

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(b) A belt conveyor consist of a flat belt 0.5 m wide which slides at a velocity of 4 m/s parallel to a surface separated by a 6 cm thick layer of oil of viscosity 0.25 N-S/m. Determine.
(i) The pressure gradient required to cause no shear stress at the belt surface.
(ii) The average velocity and discharge of oil to be maintained for the above.

8

OR

2 (a) What do you understand by hydro-dynamically smooth and rough pipes ? Prove the Karman-Prandtl's equation for velocity distribution in hydrodynamically smooth pipes.

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(b) A liquid of sq. gr. 0.90 and viscosity 6.87×10^{-4} N-S/m² flows through a pipe of diameter 15 cm at the rate of 0.07 cumecs. If the loss of head in a length of 100 m is 4.5 m, determine whether the pipe is smooth or rough.

8

UNIT-III

3 (a) A wide rectangular channel carries a discharge of 5.1 m³/s/m width of channel :
   (i) If the channel bed slope changes suddenly from 0.0009 to 0.005 sketch the possible flow profiles
   (ii) If the channel bed slope is reversed (i.e. 0.005 to 0.0009), sketch the possible flow profiles.
   Assume Chezy's C = 50.

8

(b) Derive dynamic equation of gradually varied flow stating assumptions made therein.

8

OR

3 (a) Explain clearly what is meant by "Critical depth of flow" in a channel. show that the critical depth for flow in rectangular channel with width 'B' is given by $\left[Q^2/\left(B^2\right)\right]^{\frac{1}{3}}$, where Q is the rate of flow in m³/s.

8

(b) Water flows in a channel of the shape of an isoscales triangle of bed with 'a' and sides making an angle of 45° with the bed. Determine the relation between depth of flow 'd' and bed width 'a' for maximum velocity condition and maximum discharge condition. Use Manning's formula and 'd' should be less than '–0.5a'.

8

UNIT-IV

4 (a) In case of hydraulic jump in a rectangular channel prove that

$$a^3 = \left[(x-1)^a \middle| \left\{ 32\,r^4\,(r+1) \right\} \right]$$

where $a = \dfrac{H_L}{Y_C}$ and $r = \dfrac{y_2}{y_1}$

Here, H_L is the head loss, Y_C is the critical depth of flow, and, y_1 and y_2 are the sequent depths.

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(b) Prove that the maximum efficiency of a water wheel mounted with series of flat plates on it is 50%.

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OR

4 (a) Water flows over a spillway at the rate of 300 m³/s. After flowing over the spillway, it passes over a level concrete apron (N=0.015). The velocity of water at the toe of the spillway is 15 m/s and the width of the apron is 50 m. The tail water depth is 3m. Calculate the length of the apron to contain the jump. Also calculate the energy dissipated.

8

(b) A jet strikes tangentially at one end of a smooth curved vane moving in the same direction as the jet. the jet gets reversed at the end of the vane. Show that the maximum efficiency is 59.3%. Neglect friction.

8

UNIT-V

5 (a) Draw a neat sketch of governing of Pelton wheel turbine.

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(b) A Francis turbine develops 3605.18 kW under a head of 80 m. If the specific speed is 172. Calculate the diameter and speed of runner. Take $\psi = 0.20$, $\eta_o = 0.85$, k = 0.95 and breadth ratio (n) = 0.20 where symbols carry conventional meaning.

8

OR

5 (a) What is a draft tube ? What actions are performed by it in a reaction turbine ? Derive an expression for the efficiency of a draft tube.

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(b) (i) Explain the effect of number of blades in a pump impeller.

2

(ii) Explain Net Positive Suction Head (NPSH)

2

(iii) Draw the main characteristic curves and operating characteristic curves.

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