53 (CE 605) HDEN

2014

HYDRAULIC ENGG.

Paper : CE 605

Full Marks : 100

Time : Three hours

The figures in the margin indicate full marks for the questions.

Answer ***any five*** *questions.*

1. *(a)* What is meant by an economical section of a channel ? 2

(b) Find the discharge through a V-Shaped Channel having total angle between the sides as $60°$ take the value of $C = 50$ and bed slope of the bed 1 in 1500, the depth of flow is $6m$. 5

(c) The discharge of a water through a rectangular channel of width $6m$, is $18m^3/sec$ when the depth of flow of water is $2m$ calculate :

(i) Specific energy of the flowing water

(ii) Critical depth

(iii) Critical velocity

(iv) Minimum specific energy 8

(d) Prove that the coefficient of lift for a rotating cylinder placed in a uniform flow is given by : 5

$$C_L = \frac{\Gamma}{RU}$$ where Γ = circulation

R=Radius of cylinder

U = free stream velocity

2. (a) Experiments were conducted in a wind tunnel with a wind speed of $50\,kmph$ on a flat plate of size $2m$ long and $1m$ wide. The density of air is $1{\cdot}15 kg/m^3$. The coefficient of lift and drag are $0{\cdot}75$ and $0{\cdot}15$ respectively. Determine 6

(i) the lift force

(ii) the drag force

(iii) the resultant force

(iv) direction of resultant force

(v) power exerted by air on the plate

(b) Explain the terms : 1×8=8

(i) Distorted model

(ii) Prototype

(iii) Model analysis

(iv) Hydraulic Similitude

(v) Draft tube

(vi) Equivalent pipe

(vii) Hydraulic gradient line

(viii) Total energy line

(c) Obtain an expression for velocity distribution in turbulent flow for : 6

(i) Smooth pipe

(ii) Rough pipe

3. (a) What is magnus effect'? Why it is known as magnus effect ? 2

(b) Resistance R to the motion of a completely submerged body is given by $R = \rho v^2 l^2 f\phi\left(\frac{VL}{V}\right)$ where ρ and v are density and kinematic viscosity of the fluid while l is the length of the body and V is the velocity of the flow. If the resistance of a one-eight scale air ship model when tested in water at $12\,m/sec$ is $22N$, what will be the resistance in air of the airship at the corresponding speed ? Kinematic Viscosity of air is 13 times that of water and density of water is 810 times of air. 6

(c) Derive an equation for most economical trapezoidal section. 6

(d) A nozzle of $50mm$ diameter delivers a stream of water at $20m/sec$ perpendicular to a plate that moves away from the jet at $5m/sec$, find : 6

(i) force on the plate

(ii) the work done

(iii) the efficiency of jet.

4. *(a)* A horizontal pipe line $40m$ long is connected to a water tank at one end and discharge freely into the atmosphere at the other end for the 1st $25m$ of its length from the tank, the pipe is $150mm$ diameter and its diameter is suddenly enlarged to $300mm$ the height of water level in the tank is $8m$ above the centre of the pipe. Considering all losses which occurs, determine the rate of flow take $f = 0{\cdot}01$ for both sections of the pipe. 8

(b) What do you mean by dimensionless numbers ? Name *any four* dimensionless numbers. Define and explain Reynold's number, Froude's number and mach number. Derive expression for *any* above *two* numbers. 1+1+8

(c) Classify various types of open flow channel. 2

5. *(a)* Prove that the loss of energy head in hydraulic jump is equal to $(d_2 - d_1)^3 / 4d_1d_2$. 6

(b) Show that the efficiency of a face jet striking normally on a series of flat plates mounted on the periphery of a wheel can never exceed 50%. 6

(c) A sudden enlargement of a water mains from 240*mm* to 480*mm* diameter, the hydraulic gradient rise by 10*mm*. Estimate the rate of flow. 4

(d) What factors decide whether Kaplan or Francis or Pelton type turbine would be used in a hydro electric project. How will you classify the turbines ? 4

6. (a) Derive an expression for Prandtl Universal velocity distribution for turbulent flow in pipe. 10

(b) Determine the length of the backwater curve caused by an affix of 2*m* in a rectangular channel of width 50*m* and depth 2*m*. The slope of the bed is given as 1 in 2000, take Manning's $N = 0{\cdot}03$. 5

(c) Derive an expression for the variation of depth along the length of the bed of the channel for gradually varied flow in an open channel. State clearly all the assumptions made. 5

7. *(a)* A Kaplan turbine runner is to be designed to develop 7357·5 *kW* shaft power, the net available head is 550*m*. Assume that the speed ratio is 2·09 and flow ratio is 0·68 and the overall efficiency is 60%. The diameter of the boss is 1/3*rd* of the diameter of the runner. Find the diameter of the runner, its speed and its specific speed. 6

(b) What is the expression for the drag force on a sphere, when the Reynold's number of the flow is upto 0·2. 2

(c) Explain the phenomenon of water hammer. Show that the pressure rise due to sudden closure of a valve at the end of a pipe through which water is flowing is given by :

$$P = V\sqrt{\frac{d}{1/K + P/Et}}$$

where V= velocity of flow

D = dia of pipe

K, E = Bulk and Young's Modulus

t = thickness of pipe. 8

(d) Distinguish between : 2×2=4

(i) Hydro dynamically smooth and Rough Boundary.

(ii) Turbines and pumps.
