53 (CE 605) HYEN

2015

HYDRAULIC ENGINEERING

Paper : CE 605

Full Marks : 100

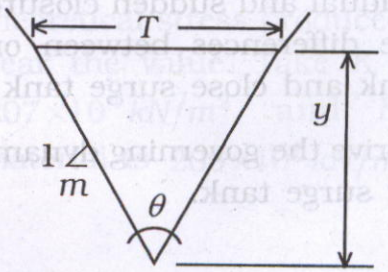
Time : Three hours

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

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

1. *(a)* What do you mean by specific energy ? When hydraulic jump occurs ? Explain with figure. Also draw the different flow profiles for mild and critical slope.

   (b) Find the critical depth and specific energy at critical depth for a triangular channel shown below.



(c) In a $4{\cdot}0m$ wide rectangular channel $(n = 0{\cdot}017)$ the bed slope is 0·0006. When the channel is conveying $10m^3/s$ of flow, estimate the nature of gradually varied flow profiles at two for away section A and B in this channel where depth of flow is measured as $1{\cdot}6m$ and $2{\cdot}1m$ respectively.

(d) A spillway discharges flood flow at a rate of $8{\cdot}5m^3/s$ 1 per *meter* width. At the downstream horizontal apron the depth of flow was found to be $0{\cdot}5m$. What tail-water depth is needed to form hydraulic jump? If a jump is formed find its *(i)* type, *(ii)* head loss, *(iii)* energy loss as a percentage of initial energy.

5+5+5+5=20

2. (a) What do you mean by water hammer? Also write down the condition for gradual and sudden closure. What are the differences between orifice surge tank and close surge tank?

(b) Derive the governing dynamic equation for surge tank.

(c) The water is flowing with a velocity of $2m/s$ in a pipe of length $2000m$ and diameter $600mm$. At the end of pipe, a value is provided. Find the rise in pressure if value is closed in 20 *sec*. Take value of $C = 1420 m/s$.

In the problem (*C*), if thickness of pipe is $10mm$ and value is closed suddenly. Find the rise in pressure if the pipe is considered to be elastic. Take $E = 19 \cdot 62 \times 10^6 N/cm^2$ for pipe material and $K = 19 \cdot 62 \times 10^4 N/cm^2$ for water. Also calculate circumferential stress and longitudinal stress developed in pipe wall.

(d) Water is flowing in a long pipe which is $0 \cdot 15m$ diameter and $6 \cdot 25mm$ thick with a velocity of $1 \cdot 2m/s$ and it is suddenly brought rest by the closing of a value. Calculate the inertia pressure and theoretical stress produced in the pipe near the value. Take K for water is $207 \times 10^4 kN/m^2$ and E for pipe material is $206 \times 10^6 kN/m^2$.

5+5+5+5=20

3. *(a)* What do you mean by momentum thickness in boundary layer? Derive the governing equation for momentum thickness in boundary layer.

(b) For the following type of velocity distribution obtain the value of $\left(\frac{\delta^*}{\delta}\right), \left(\frac{\theta}{\delta}\right)$.

$$\frac{u}{v_0} = 2\eta - 2\eta^3 + \eta^4 \text{ where } \eta = \left(\frac{y}{\delta}\right)$$

(c) A plate of 600*mm* length and 400*mm* wide is immersed in a fluid of specific gravity 0·9 and kinematic viscosity of $10^{-4}\, m^2/s$. The fluid is moving with velocity of $6m/s$. Determine *(i)* boundary layer thickness, *(ii)* shear stress at the end of plate and *(iii)* drag force on a one side of plate.

(d) Determine the thickness of boundary layer at the trailing edge of smooth plate of length $4m$ and width $1{\cdot}5m$. When the plate is moving with velocity of $4m/s$ in stationary air.

Also determine the total drag on one side of the plate assuming that *(i)* boundary layer is laminar over entire plate and *(ii)* the boundary layer is turbulent from very beganing. Take kinematic viscosity of air is

$1 \cdot 5 \times 10^{-5} m^2/s$ and density of air is $1 \cdot 226 kg/m^3$. 5+5+5+5=20

4. *(a)* Write a full description about Karmom Vortex trails.

(b) What do you mean by terminal fall velocity ? How to determine terminal fall velocity for a free falling particle ?

(c) Experiments were conducted in a wind tunnel with a wind speed of $50 km/hour$ 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 drag & lift are 0·15 and 0·75 respectively. Determine *(i)* the lift force, *(ii)* drag force, *(iii)* resultant force, *(iv)* direction of resultant force and *(v)* power exerted by air on the plate.

(d) The air having velocity of $40 m/s$ is flowing over a cylinder of diameter $1 \cdot 5m$ and length $10m$, when the axis of the cylinder is perpendicular to the airstream. The cylinder is rotated about its axis and a lift of $6867N$ per *meter* length of the cylinder is developed. Find the speed of rotation and location of the stagnation point. The density of air is given as $1 \cdot 25 kg/m^3$.

5+5+5+5=20

5. *(a)* Write down the prandtl mixing length theory for turbulent shear stress.

(b) Write in details about flow characteristic over hydrodynamically smooth and rough boundaries.

(c) A smooth brass pipeline 75*mm* in diameter and 900*m* long carriers water at the rate of 7 *litres* per second. If the kinetic viscosity of water is 0·0195 strokes, calculate the head loss, wall shearing stress, centre line velocity, shear stress and velocity at 25*mm* from the centre line and thickness of laminar sublayer.

(d) Determine the wall shear stress in a pipe diameter 100*mm* which carries water. The velocities at the pipe centre and 30*mm* from the pipe centre are 2*m/s* and 1·5*m/s* respectively. The flow in pipe is given as turbulent.

5+5+5+5=20

6. *(a)* Find an expression for drag force on smooth sphere of diameter D, moving with a uniform velocity V in a fluid density and dynamic viscosity μ.

(b) Write down the Buckingham's-II theorem. Also, describe the method of selecting repeating variables with examples.

(c) What do you mean by similitude ? Write down the different type of similarity exist between model and prototype with short description each.

(d) The pressure drop in an aeroplane model of size 1/40 of its prototype is $80 N/cm^2$. The model is tested in water. Find the corresponding pressure drop in the prototype.

Take density of air $1 \cdot 24 kg/m^3$. The viscosity of water is 0·01 *poise* while viscosity of air is 0·00018 *poise.*

5+5+5+5=20

7. (a) A jet of water of diameter 75*mm* moving with a velocity of 30*m/s*. Strikes a curved fixed plate tangentially at one end at an angle of 30° to the horizontal. The jet leaves the plate at an angle 20° to the horizontal. Find the force exerted by the jet on the plate in the horizontal and vertical direction.

(b) Write down the definition of hydraulic efficiency, mechanical efficiency, volumetric efficiency and overall efficiency of a turbine.

(c) Write down the different classification of hydraulic turbine. 10+5+5=20
