BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, PILANI – 333 031

First Semester, 2016–2017 Comprehensive Examination

Course No. & Title: CE F312 Hydraulics Engineering

Date & Time: 3rd Dec. 2016 (900 Hrs to 1200 Hrs: 900-9.30 Hrs (CB); 930-1200 Hrs (OB)

Weight & Nature: 105 (25 Closed Book + 80 Open Book) A

Part A (CB)

Name: _____ ID.NO.: _____

Answer in given space. Tick the correct alternatives in the sheet. Part B will not be given before 30 mts.

Q.1 Multiple choice questions with one or more than one options correct: Exact correct alternatives will fetch you full marks, otherwise no marks on partially correct alternatives.

1. Which of the following statements are correct in respect of steady laminar flow through a circular pipe?

a. Shear stress is zero at the centre b. Discharge varies directly with the viscosity of the fluid

c. Velocity is maximum at the center d. Hydraulic gradient varies directly with the velocity.

2. Which of the following statements are correct pertaining to pumps operation

a. Pumps in series operation allow the head to increase b. Pumps in series operation increase the flow rate

c. Pumps in parallel operation increase the flow rate d. Pumps in parallel operation allow the head to increase

3. Which of the following are correct for the pipe networks

a. Pipe network analysis is normally necessary in analyzing flow in pipes at city water systems

b. Hardy-Cross method of solving pipe network is a method of successive approximations and is not a direct method

c. The pipe network must satisfy the momentum equation because the flow in each pipe satisfies the head loss equation d. Principle of continuity is satisfied in a pipe network

4. Pick the correct statements based on the concepts of the boundary layer theorem

a. Flow is established in a pipe when the boundary layer thickness is equal to the radius of the pipe

b. For laminar flow, the friction factor in Darcy-Weisbach equation varies inversely as the Reynolds number

c. For the turbulent flow, the friction factor is Darcy-Weisbach equation varies inversely as the square of Reynolds number d. When the boundary is rough, the friction factor varies with the relative roughness of the pipe.

5. Which of the following are correct with respect to the equation names mentioned in each option

a. Moment of momentum equation is a three-dimensional equation of motion based on principle of conservation of momentum for ideal and incompressible fluid b. Bernoulli's equation is based on conservation of momentum principle applicable to circulatory flow c. Euler's equation is a three-dimensional equation of motion based on principle of conservation of momentum for ideal and incompressible fluid d. Hagen-Poiseuille equation is used to find energy loss in a pipeline having laminar flow

6. Consider the various objects in the fluid and drag coefficients

a. Drag coefficient of submarine is 0.15 b. Drag coefficient of Parachute is 1.33

c. Drag coefficient of Aircraft wing (air foil) is 0.10 d. Drag coefficient of smoke stack (Chimney) is 1.00

7. The critical depth is the depth of flow at which

(a) discharge is maximum (b) Specific energy is minimum (c) specific force is minimum

(d) Froude number is one.

8. The conditions for most efficient trapezoidal channel section is/are:

(a) for the depth of flow to be constant, $\theta = 60°$

(b) bottom width to be constant,: half the top width must be equal to one of the sloping sides of the channel

(c) $B/y = 2/\sqrt{3}$ (d) for the depth of flow to be constant , $\theta = 45°$

9. The supercritical flow takes place in channel and a hump is provided at a section on downstream side so that the critical flow occurs at the contracted section. If the height of hump is increased further,

(a) the upstream depth is reduced (b) upstream depth is increased

(c) the critical flow occurs at the contracted section (d) no flow takes place at given specific force

10. The prejump and post jump depths are related as

(a) $y_2 = -\frac{y_1}{2} + \sqrt{\left(\frac{y_1}{2}\right)^2 + \frac{2q^2}{gy_1}}$ (b) $\frac{y_1}{y_2} = \frac{1}{2}\left[-1 + \sqrt{1+8Fr_2^2}\right]$ (c) $y_2 = -\frac{y_1}{2} - \sqrt{\left(\frac{y_1}{2}\right)^2 + \frac{2q^2}{gy_1}}$

(d) $y_2 = \frac{y_1}{2} + \sqrt{\left(\frac{y_1}{2}\right)^2 + \frac{2q^2}{gy_1}}$

Q.2 True/False with proper justification: Wrong answer with justification will fetch negative 100% mark. Correct answer without proper justification will not fetch any mark

1. In fully developed turbulent flow in a pipe, the shear stress is a minimum at the pipe surface. **(T/ F)**

2. A smooth flat plate 1.5 m wide and 20 m long is subjected to flow of water along its length with a velocity of 2 m/s $\vartheta = 1 * 10^{-6} m^2/s$). The extent of the laminar boundary layer on the plate exists in the first 25 cm of the plate. **(T/ F)**

2. At the critical state of flow, the specific force is a minimum for the given discharge. **(T/ F)**

3. A hydraulic jump cannot be expected in a long steep slope (fed by a large reservoir) when it is followed by a short stretch of adverse slope terminating in a deep and wide reservoir. **(T/ F)**

5. A vertical sluice gate with an opening of 0.67 m produces a downstream jet with a depth of 0.40 m when installed in a long rectangular channel, 5.0 m wide, conveying a steady discharge of 20 m3/s. It is assumed that the flow downstream of the gate eventually returns to a uniform flow depth of 2.5 m. A jump will form. **(T/ F)**

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1. Water flows from under a sluice into a very wide rectangular channel. the bed slope is 1/1000. the sluice is regulated to discharge5m^3/s/m width of channel so that the depth at venacontracta becomes 0.5m. Will a hydraulic jump form in the channel or not? (Justify). If so, find the location of the jump. Take n= 0.02. If the height of barrier at downstream side is 1.8m from channel bed, find the distance from sluice to barrier. You can use graph/ solve analytically. (25)

2. Derive the Expression for average drag coefficient if Boundary layer changes from Laminar to turbulent at $Re_x = 1.5x10^6$, for a flat plate of length L. (15)

3. A trapezoidal channel with a base width of 6m and side slopes of 2H:1V conveys water at 17m^3/s with a depth of 1.5m. Is the flow sub critical or super critical. Find the alternate depths. (15)

4. A cloth banner 4m wide and 1.0m high, meant for advertisement, is mounted on poles. calculate the net force acting on the banner when wind blows at 50km/h. assume C_d = 1.1, ρ= 1.25kg/m^3. If a number of holes are punched on the cloth how would the result change and why. (10)

5. A channel is to be designed to give a constant velocity of flow 1.8m/s at all depths of flow. the lower portion of the channel is trapezoidal and is to carry minimum discharge. The trapezoidal section is to be designed with best proportions, the bottom width being 1.5m. determine the depth of flow when the width at the water surface be 10m. assuming Manning's n = 0.015, determine the bed slope of the channel. (15)

6. An old pipe 2 m in diameter has a roughness of ε=30mm. A 12-mm-thick lining would reduce the roughness to ε=1mm. How much in annual pumping costs would be saved per kilometer of pipe for water at 20°C with discharge of 6 m^3/s? The pumps and motors are 80% efficient, and power costs Rs. 6 per kilowatt-hour. (10)