BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI
(END SEMESTER EXAMINATION)

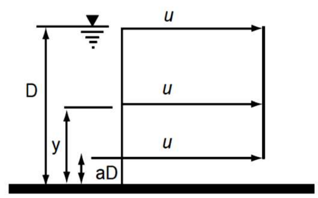
CLASS: BE **SEMESTER : V**
BRANCH: CIVIL **SESSION : MO/19**

SUBJECT: CE5003 FLUID MECHANICS II

TIME: 3 HOURS **FULL MARKS: 60**

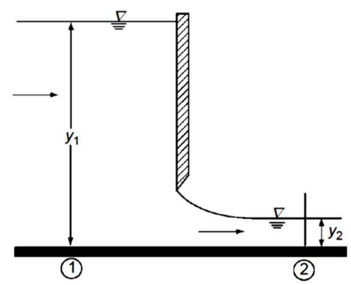
INSTRUCTIONS:
1. The question paper contains 7 questions each of 12 marks and total 84 marks.
2. Candidates may attempt any 5 questions maximum of 60 marks.
3. The missing data, if any, may be assumed suitably.
4. Before attempting the question paper, be sure that you have got the correct question paper.
5. Tables/Data hand book/Graph paper etc. to be supplied to the candidates in the examination hall.

Q.1(a) Determine the kinetic energy correction factor α and momentum correction factor β for the following velocity profile. [4]



Q.1(b) A sluice gate in a rectangular channel is shown in the given figure. Fill the missing data in the table below. [4]

Case	y_1 (m)	y_2 (m)	q ($m^2/s/m$)	Losses
(i)	--	0.30	2.5	Neglect
(ii)	4.0	--	2.0	Neglect
(iii)	4.0	--	2.0	0.1 $V_2^2/2g$
(iv)	3.0	0.25	--	Neglect



Q.1(c) Derive the continuity equation for unsteady flow in an open channel. [4]

Q.2(a) A trapezoidal channel is 10.0 m wide and has a side slope of 1.5 horizontal: 1 vertical. The bed slope is 0.0003. The channel is lined with smooth concrete of n = 0.012. [4]
(i) Compute the mean velocity and discharge for a depth of flow of 3.0 m.
(ii) Find the bottom slope necessary to carry only 50 m^3/s of the discharge at a depth of 3.0 m.

Q.2(b) What do you mean by equivalent roughness? Derive Horton's formula for equivalent roughness. [4]

Q.2(c) Derive the parameters of most efficient channel cross-section for a trapezoidal channel. [4]

Q.3(a) A 2.5-m wide rectangular channel has a specific energy of 1.50 m when carrying a discharge of 6.48 m^3/s. Calculate the alternate depths and corresponding Froude numbers. [3]

Q.3(b) A trapezoidal channel with a bed width of 4.0 m and side slopes of 1.5 H: I V carries a certain discharge. [4]
(i) If the critical depth of the flow is estimated as 1.70 m, calculate the discharge in the channel.
(ii) If this discharge is observed to be flowing at a depth of 2.50 m in a reach, estimate the Froude number of the flow in that reach.

Q.3(c) A uniform flow of 12.0 m^3/s occurs in a long rectangular channel of 5.0 m width and depth of flow of 1.50 m. A flat hump is to be built at a certain section. Assuming a loss of head equal to the upstream velocity head, compute the minimum height of the hump to provide critical flow. What will happen [5]
(i) if the height of the hump is higher than the computed value, and
(ii) if the energy loss is less than the assumed value?

Q.4(a) Write down the steps required to compute the water surface profiles using Direct Step and Standard Step method. [4]

Q.4(b) A 4.0-m wide rectangular channel has a Manning's coefficient of 0.025. For a discharge of 6.0 m^3/s, identify the possible types of GVF profiles produced in the following break in grades: [4]
(i) S_{01} = 0.0004 to S_{02} = 0.005
(ii) S_{01} = 0.015 to S_{02} = 0.0004

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Q.4(c) Show various types of water surface profiles with neat sketches. [4]

Q.5(a) Derive the relations for sequent depth ratio and energy loss for hydraulic jump in a horizontal non-rectangular channel. [4]

Q.5(b) A rectangular channel carries a flow with a velocity of 0.65 m/s and depth of 1.40 m. If the discharge is abruptly increased threefold by a sudden lifting of a gate on the upstream, estimate the velocity and the height of the resulting surge. [4]

Q.5(c) A rectangular channel is laid on a slope of 1 horizontal: 0.15 vertical. When a discharge of 11.0 m^3/s/metre width is passed down the channel at a depth of 0.7 m, a hydraulic jump is known to occur at a section. Calculate the sequent depth, length of the jump and energy loss in the jump. [4]

Q.6(a) What is cavitation in Pumps? What are the causes for its occurrence and remedial measures to prevent the cavitation? [4]

Q.6(b) The internal and external diameters of the impeller of a centrifugal pump are 200 mm and 400 mm respectively. The pump is running at 1200 rpm. The vane angles of the impeller at inlet and outlet are 20° and 30° respectively. The water enters the impeller radially and velocity of flow is constant. Determine the work done by the impeller per unit weight of water. [4]

Q.6(c) The outer diameter of an impeller of a centrifugal pump is 400 mm and outlet width is 50 mm. The pump is running at 800 rpm and is working against a total head of 15 m. The vanes angle at outlet is 40° and manometric efficiency is 75%. Determine: [4]

(i) Velocity of flow at outlet,
(ii) Velocity of water leaving the vane,
(iii) Angle made by the absolute velocity at outlet with the direction of motion at outlet, and
(iv) Discharge.

Q.7(a) A Pelton wheel is revolving at a speed of 190 rpm and develops 5150.25 kW when working under a head of 220 m with an overall efficiency of 80%. Determine unit speed, unit discharge and unit power. The speed ratio for the turbine is given as 0.47. Find the speed, discharge and power when this turbine is working under a head of 140 m. [4]

Q.7(b) A 137 mm diameter jet of water issuing from a nozzle impinges on the buckets of a Pelton wheel and the jet is deflected through an angle of 165° by the buckets. The head available at the nozzle is 400 m. Assuming co-efficient of velocity as 0.97, speed ratio as 0.46, and reduction in relative velocity while passing through buckets as 15%, find: [4]

(i) The force exerted by the jet on buckets in tangential direction, and
(ii) The power developed.

Q.7(c) A Kaplan turbine working under a head of 20 m develops 11772 kW shaft power. The outer diameter of the runner is 3.5 m and hub diameter is 1. 75 m. The guide blade angle at the extreme edge of the runner is 35°. The hydraulic and overall efficiencies of the turbines are 88% and 84% respectively. If the velocity of whirl is zero at outlet, determine: [4]

(i) Runner vane angles at inlet and outlet at the extreme edge of the runner, and
(ii) Speed of the turbine.

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