Code No: R1622013 **R16** SET - 1

II B. Tech II Semester Regular/ Supplementary Examinations, April/May - 2019
HYDRAULICS AND HYDRAULIC MACHINERY
(Civil Engineering)

Time: 3 hours Max. Marks: 70

Note: 1. Question Paper consists of two parts (**Part-A** and **Part-B)**
2. Answer **ALL** the question in **Part-A**
3. Answer any **FOUR** Questions from **Part-B**

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PART –A

1. a) Define Uniform flow and Non-Uniform flow. (2M)
   b) What is gradually varied flow? (2M)
   c) Write the significance of Reynolds number. (2M)
   d) A jet of water 50 mm diameter having a velocity of 15 m/s strikes normally a flat smooth plates which is moving in the same direction as the jet with a velocity of 6 m/s. Find the work done. (3M)
   e) What is meant by governing of turbine? (2M)
   f) Define the following and write corresponding equations: (3M)
   (i) Manometer efficiency (ii) Volumetric efficiency

PART -B

2. a) Find the bed slope of trapezoidal channel of bed width 7m, depth of water 4m and side slope of 3 horizontal to 4 vertical, when the discharge through the channel is 40 m^3/s. Take Chezy's Constant, C= 65. (7M)
   b) Illustrate the differences between flow through pipes and flow through channels. (7M)

3. a) Compare and contrast Rapidly varied flow and Gradually varied flow. (6M)
   b) The depth of flow of water, at a certain section of a rectangular channel of 2.5 m wide, is 0.5 m. The discharge through the channel is 2.0 m^3/sec. Determine whether a hydraulic jump will occur, and if so, find its height and loss of energy per kg of water. (8M)

4. a) State and explain Buckingham's pi theorem. Give one example. (6M)
   b) For laminar flow in a pipe the drop in pressure p is a function of pipe length 1, its diameter d, mean velocity of flow v, and viscosity of fluid μ. Using Rayleigh's method obtain an expression for p. (8M)

5. a) Write short note on impact of jet on vanes. (6M)
   b) A 50 mm diameter jet having a velocity of 25 m/s strikes a flat plate, the normal of which is inclined at 30^o to the axis of the jet. Calculate the normal force exerted on the plate. (8M)
   (i) When the plate is stationary and
   (ii) When the plate is moving with a velocity of 8 m/s parallel to itself and in the direction of the normal to its surface. Also find the work done and efficiency of the jet when the plate is moving.
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6. a) Explain draft tube theory and derive an expression for the efficiency of a draft tube. (7M)
   b) What are unit quantities? Derive the expressions for unit discharge, unit speed and unit power. (7M)

7. a) Define a centrifugal pump. Explain the working of a single -stage centrifugal pump with sketches. (8M)
   b) For a single acting reciprocating pump, piston diameter D is 150 mm, stroke length L is 300 mm, rotational speed N is 50 rpm and the water is to be raised through 18 m. Determine theoretical discharge Q_t. If the actual discharge is 40 liter/sec, determine volumetric efficiency, slip and actual power required; take the mechanical efficiency as 80%. (6M)

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PART –A

1. a) What is the condition for most economical triangular section of open channel? (2M)
   b) Mention any four channel bottom slopes. (2M)
   c) Explain the significance of Weber number. (2M)
   d) Draw the neat sketch of force exerted by fluid jet on moving flat plate normal to the jet. (3M)
   e) Give the definition for specific speed of a turbine. (2M)
   f) Define the following and write corresponding equations: (3M)
   (i) Mechanical efficiency (ii) Overall efficiency

PART -B

2. a) Briefly explain different types of flow in channels. (8M)
   b) A rectangular channel carries water at the rate of 300 liters/sec when bed slopes is 1 in 2000. Find the most economical dimension of the channel if C=55 and justify your answer. (6M)

3. a) Derive the dynamic equation for gradually varied flow. (8M)
   b) A hydraulic jump forms at the downstream end of spillway carrying 18.74 m^3/sec discharge. If the depth before jump is 0.80 m, determine the depth after the jump and energy loss. (6M)

4. a) Explain the similarities that must exist between prototype and model. (8M)
   b) A 1:50 spillway model has a discharge of 1.25m^3 /s. What is the corresponding prototype discharge? If a flood phenomenon takes 12 hours to occur in the prototype, how long should it take in the model? (6M)

5. a) A jet of water of diameter 12cm strikes a flat plate normally with a velocity of 18m/s. The plate moving with a velocity of 7m/s in the direction of the jet and away from the jet. Find: (8M)
   (i) The force exerted by the jet on the plate
   (ii) Work done by the jet on the plate per second
   (iii) Find the power
   (iv) Efficiency of the jet
   b) Obtain an expression for the force exerted by a jet of water on a fixed vertical plate in the direction of the jet. (6M)
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6. a) With the help of a neat sketch explain various components in Francis turbine. (7M)

   b) The external and internal diameters of an inward flow reaction turbine running at 180rpm are 1.2m and 0.60m respectively. The width of the wheel at inlet is 300mm. The guide vane angle is 10^0. The velocity of flow at inlet is 2.20m/s, find: (7M)
      (i) The discharge through the turbine
      (ii) Inlet an outlet angles
      (iii) The power developed
      (iv) The hydraulic efficiency. Assume that the velocity of flow through the runner is constant and that the turbine is discharging radially at outlet.

7. a) A centrifugal pump runs at 1000 rpm and delivers water against a head of 15 m, the impeller diameter and width at the outlet are 0.3 and 0.05 m respectively. The vanes are curved back at an angle of 30^0 with the periphery at the outlet. If the maximum efficiency is 92%, find the discharge. (7M)

   b) Draw the ideal indicator diagram of a reciprocating pump. Obtain the expression for work done from it. (7M)

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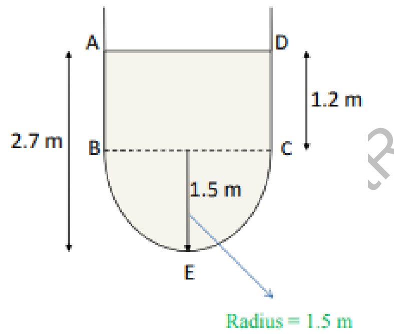
PART –A

1. a) What do you understand by 'steady and unsteady flow' in the case of channels? (3M)
   b) What is rapidly varied flow? (2M)
   c) Explain the term geometric similarity (2M)
   d) Write an expression for force exerted by jet on stationary vertical plate? (2M)
   e) What is the purpose of draft tube in the turbine? (3M)
   f) How cavitation can be prevented in centrifugal pump (2M)

PART –B

2. a) Derive an expression for the discharge through a channel by chezy's formulae. (8M)
   b) Find the discharge of water through the channel shown in figure below. Take the value of Chezy's constant = 55 and slope of the bed as 1 in 1500. (6M)



3. a) What is meant by G.V.F? Derive the equation of G.V.F in terms of Froude number. (8M)
   b) What are the characteristics and uses of hydraulic jump? (6M)

4. a) What are the methods of dimensional analysis? Describe the Rayleigh's method for dimensional analysis. (8M)
   b) Write the dimensions for the following quantities (i) pressure intensity (ii) dynamic viscosity (iii) power (iv) surface tension (6M)

5. a) Show that the efficiency of a jet striking normally on a series of flat plates mounted on the periphery of a wheel never exceeds 50%. (7M)
   b) A jet of water of diameter 55 mm strikes a fixed plate in such a way that the angle between the plate and the jet is 30°. The force exerted in the direction of the jet is 1541.7N. Determine the rate of flow of water. (7M)
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6. a) Draw a neat sketch of Kaplan turbine and explain its parts. (7M)

   b) Classify the Hydraulic turbines and comment on the suitability of turbines when the working head is 80m. (7M)

7. a) Explain the main parts of a reciprocating pump with a neat sketch. (7M)

   b) The internal and external diameters of the impeller of a centrifugal pump are 200mm and 400mm respectively. The pump is running at 1200rpm. The vane angles of the impeller at inlet and outlet are 20^0 and 30^0 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. (7M)

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2. Answer **ALL** the question in **Part-A**
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PART –A

1. a) What do you mean by most economical section of a channel? (2M)
   b) Define hydraulic jump. (2M)
   c) What are the limitations of Reyleigh's method of dimensional analysis? (2M)
   d) What is the principle of angular momentum? (3M)
   e) Give an example for axial flow hydraulic turbine. (2M)
   f) Define manometric head of centrifugal pump. (3M)

PART –B

2. a) Derive an expression for critical depth for an open channel. (6M)
   b) A trapezoidal channel has side slopes of 1 horizontal to 2 vertical and the slope of the bed is 1 in 1000. The area of the section is 45 m^2. Determine the dimension of the section if it is most economical. Also determine the discharge of the most economical section if C=60. (8M)

3. a) Explain the terms: specific energy of a flowing liquid, minimum specific energy, critical depth, critical velocity and alternate depths as applied to non-uniform flow. (10M)
   b) The depth of flow of water, at a certain section of a rectangular channel of 4m wide is 0.5 m. This discharge through the channel is 16 m^3/sec. If a hydraulic jump takes place on the downstream side, find the depth of flow after the jump. (4M)

4. a) The drag force F_D on a sphere in laminar flow is known to depend on its diameter D, velocity of flow V, density of fluid ρ, coefficient of viscosity μ. Obtain an expression for F_D using Raleigh's method. (8M)
   b) What is meant by dimensional analysis? What are the uses? (6M)

5. a) A jet of water moving at 12m/s impinges on vane shaped to deflect the jet through 120^0 when stationary. If the vane is moving at 5m/s find the angle of the jet so that there is no shock at inlet. What is the absolute velocity of the jet at exit in magnitude and direction and the work done per second per unit weight of water striking per second? Assume that the vane is smooth. (8M)
   b) Derive an expression for force exerted by jet on a series of flat plates mounted on a wheel when it striking at the centre. Also obtain the condition for maximum efficiency. (6M)
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6. a) What is Cavitation? Explain its effects on performance of turbines. (8M)
   b) A pelton wheel is having a mean bucket diameter of 1.2 m and is running at 1200rpm. The net head on the pelton wheel is 800m. If the side clearance angle is 18° and discharge through nozzle is $0.25 m^3/s$, find the power available at the nozzle and hydraulic efficiency of the turbine. (6M)

7. a) Derive an expression for the minimum starting speed of a centrifugal pump. (7M)
   b) A single-acting reciprocating pump, running at 50rpm and delivers $0.01 m^3/s$ of water. The diameter of the piston is 200mm and stroke length 400mm. Determine the theoretical discharge and coefficient of discharge of the pump. (7M)