Code No: R2022013 **R20** **SET - 1**

II B. Tech II Semester Regular/Supplementary Examinations, July - 2023
HYDRAULICS AND HYDRAULIC MACHINERY
(Civil Engineering)

Time: 3 hours **Max. Marks: 70**

Answer any **FIVE** Questions, each Question from each unit
All Questions carry **Equal** Marks
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UNIT-I

1 a) What are the energy and momentum correction factors and how are they calculated? [7M]
b) A rectangular channel has a discharge of 10 m^3/s and a slope of 1 in 1000. The channel has a roughness coefficient of 0.015. Calculate the value of Chezy's constant and the velocity of flow in the channel. [7M]

Or

2 a) What is the critical depth in uniform flow? How is it related to the flow rate and channel geometry. [6M]
b) A trapezoidal channel has a bottom width of 4 m, a side slope of 1:2 and a flow rate of 15 m^3/s. Determine the specific energy of the flow and the critical depth of the channel. [8M]

UNIT-II

3 a) What is meant by gradually varied flow? What is the dynamic equation for steady gradually varied flow? [6M]
b) A rectangular channel with a width of 12 meters and a depth of 4 meters is carrying a discharge of 120 m^3/s. A sudden contraction of the channel occurs and the width of the channel reduces to 6 meters. Determine the depth of flow at the end of the contraction if the initial depth of flow is 3 meters. The bed slope of the channel is 0.002 and the Manning's roughness coefficient is 0.025 [8M]

Or

4 a) What are the three different types of channel slope profiles in gradually varied flow? [6M]
b) A trapezoidal channel with a bottom width of 8 meters and side slopes of 2:1 is carrying a discharge of 80 m^3/s. The bed slope of the channel is 0.0025 and the Manning's roughness coefficient is 0.022. Determine the water surface profile using the direct step method. [8M]

UNIT-III

5 a) What is geometric similarity in hydraulic models? How can it be achieved? [7M]
b) A model of a river is being built in a laboratory, where the flow rate is to be scaled down by a factor of 50. If the prototype river has a width of 50 meters, what should be the width of the model river? [7M]

Or

6 a) Describe the different types of dimensionless numbers used in hydraulic modeling. Explain the significance of each number. [7M]
b) A pump delivers 5000 liters of water per minute to a prototype hydraulic system. If the model is 1/10th scale, what should be the flow rate in the model system? [7M]
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UNIT-IV

7 a) Explain the concept of hydrodynamic force of jets on stationary vanes. What factors affect the magnitude and direction of the force? [7M]

b) A gas turbine operates on an open cycle with air as the working fluid. The turbine has an inlet temperature of 300°C and an inlet pressure of 1 bar. The outlet pressure is 0.1 bar, and the mass flow rate of air through the turbine is 20 kg/s. If the turbine efficiency is 85%, what is the power output of the turbine? [7M]

Or

8 a) Derive the expression for the work done by a jet on a flat plate. What assumptions are made in this derivation? [7M]

b) A Pelton wheel is designed to operate with a water jet velocity of 30 m/s and a flow rate of 0.02 m^3/s. The wheel has a diameter of 1 meter and is equipped with 20 buckets. If the efficiency of the wheel is 80%, what is the power output of the wheel? [7M]

UNIT-V

9 a) What is the layout of a typical hydropower installation, and how do the heads and efficiencies affect the design of the turbines? [7M]

b) A reciprocating pump has a piston diameter of 0.1 m and a stroke length of 0.2 m. If the pump operates at a speed of 300 rpm and a discharge of 0.05 m^3/s, what is the work done and slip of the pump? [7M]

Or

10 a) What are the different types of hydraulic turbines, and how are they classified based on their working principles? [7M]

b) A centrifugal pump operates at a flow rate of 0.1 m^3/s and a head of 40 m. If the NPSH available is 6 m and the NPSH required is 4 m, will the pump experience cavitation? If yes, what is the value of the cavitation index and the minimum NPSH required to prevent cavitation. [7M]

Code No: R2022013 **R20** **SET - 2**

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(Civil Engineering)

Time: 3 hours **Max. Marks: 70**

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All Questions carry **Equal** Marks
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UNIT-I

1 a) What is the significance of the slope of a channel in non-uniform flow? [7M]
b) A channel has a rectangular cross section with a width of 6 m and a depth of 2 m. The channel has a flow rate of 10 m^3/s and a specific energy of 6 m. Determine the location of the hydraulic jump. [7M]

Or

2 a) What is the direct step method and how is it used to solve non-uniform flow problems? [7M]
b) A channel has a slope of 1:5000 and a discharge of 20 m^3/s. Determine the type of flow (mild, critical or steep). [7M]

UNIT-II

3 a) What is the Froude number and how is it related to gradually varied flow? [7M]
b) A rectangular channel with a bottom width of 6 meters and a side slope of 1:1 is carrying a discharge of 60 m^3/s. The channel bed slope is 0.0005 and the Manning's roughness coefficient is 0.025. Determine the water surface profile using the direct step method. [7M]

Or

4 a) What is meant by specific energy in RVF? How is the momentum equation used in RVF analysis? [6M]
b) A rectangular channel with a width of 10 meters and a depth of 3 meters is carrying a discharge of 100 m^3/s. A sudden expansion of the channel occurs and the width of the channel increases to 20 meters. Determine the depth of flow at the end of the expansion if the initial depth of flow is 2.5 meters. The bed slope of the channel is 0.001 and the Manning's roughness coefficient is 0.02. [8M]

UNIT-III

5 a) What are the advantages and limitations of using hydraulic models in engineering design and analysis? Provide some examples [7M]
b) A hydraulic model is being built to simulate the flow in a river with a discharge of 10 m^3/s. The model is to be 1/50th scale. Calculate the discharge in the model. [7M]

Or

6 a) Explain the concept of Buckingham's pi theorem. How can it be used to derive dimensionless expressions for hydraulic models? [7M]
b) A model of a dam is being built in a laboratory. If the prototype dam is 40 meters high and the model is to be 1/50th scale, what should be the height of the model dam? [7M]
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UNIT-IV

7 a) Describe the angular momentum principle and its application in the theory of turbo machinery. [7M]

b) A centrifugal pump has an inlet diameter of 0.2 m and an outlet diameter of 0.1 m. If the velocity of the water at the inlet is 10 m/s and the outlet is 20 m/s, what is the efficiency of the pump? [7M]

Or

8 a) Describe the working principle of a centrifugal pump. [6M]

b) A pump is required to lift water from a well that is 20 meters deep and deliver it to a storage tank located 50 meters away and at an elevation of 10 meters above the pump. If the flow rate required is 0.02 m^3/s and the pump efficiency is 75%, what is the power required by the pump? [8M]

UNIT-V

9 a) What is the Pelton wheel, and how does it work? What are the working proportions, velocity diagram, work done, and efficiency of the Pelton wheel? [7M]

b) A centrifugal pump has a diameter of 0.5 m and a flow rate of 0.1 m^3/s. If the head developed by the pump is 30 m, what is the power input required to operate the pump and its efficiency? [7M]

Or

10 a) Explain the working principle of the Francis turbine. How does its hydraulic design affect its efficiency, and what is the role of the draft tube in this turbine? [7M]

b) A multistage pump has four identical stages and operates at a flow rate of 0.2 m^3/s and a head of 80 m. If the efficiency of each stage is 75%, what is the total power input required to operate the pump and its specific speed? [7M]

Code No: R2022013 **R20** **SET - 3**

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HYDRAULICS AND HYDRAULIC MACHINERY

(Civil Engineering)

Time: 3 hours **Max. Marks: 70**

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All Questions carry **Equal** Marks

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UNIT-I

1 a) What are the different types of hydraulic jumps and how do they differ in terms of energy dissipation and geometry? [7M]

b) A channel has a rectangular cross section with a width of 6 m and a depth of 2.5 m. The channel has a flow rate of 8 m^3/s and a slope of 1:5000. Determine the flow depth and the average velocity of the flow. [7M]

Or

2 a) What is the significance of energy dissipation in hydraulic jump design? [7M]

b) A rectangular channel has a flow rate of 15 m^3/s and a specific energy of 5 m. Determine the location of the hydraulic jump and the energy dissipated. [7M]

UNIT-II

3 a) Explain the concepts of mild, critical, and steep slopes in open channel flow. [6M]

b) A rectangular channel with a width of 8 meters and a depth of 3 meters is carrying a discharge of 80 m^3/s. A standing wave occurs due to a sudden change in the downstream slope. Determine the depth of flow at the crest of the wave if the bed slope of the channel is 0.002 and the Manning's roughness coefficient is 0.026 [8M]

Or

4 a) A rectangular channel with a width of 10 meters and a depth of 3 meters is carrying a discharge of 100 m^3/s. The channel bed slope is 0.002 and the Manning's roughness coefficient is 0.025. Determine the water surface profile using the direct step method for a horizontal slope condition. [7M]

b) A circular pipe with a diameter of 1 meter is carrying a discharge of 2 m^3/s. The pipe slope is 0.002 and the Manning's roughness coefficient is 0.015. Determine the water surface profile using the direct step method. [7M]

UNIT-III

5 a) What is hydraulic similarity? Explain the different types of similarities in hydraulic models. [7M]

b) A model of a ship is being tested in a wave tank. If the model is 1/20th scale and experiences a wave height of 2 meters, what should be the corresponding wave height for the prototype ship? [7M]

Or

6 a) Describe the Rayleigh's method of dimensional analysis. What are the limitations of this method? [7M]

b) A model of a hydraulic turbine is being tested in a laboratory. If the prototype turbine has a power output of 10 MW and the model is 1/10th scale, what should be the power output of the model turbine? [7M]
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UNIT-IV

7 a) Derive the expression for the force exerted by a jet of water on an inclined fixed plate in the direction of the jet. [7M]

b) A turbine has an inlet diameter of 0.5 m and an outlet diameter of 0.3 m. If the velocity of the water at the inlet is 15 m/s and the outlet is 25 m/s, what is the work done by the turbine per unit mass of water flowing through it? [7M]

Or

8 a) What is the effect of the radius of curvature of a vane on the force exerted by a jet? [6M]

b) A jet of water strikes a moving flat vane with a velocity of 25 m/s. If the vane is moving with a velocity of 10 m/s in the same direction as the jet, what is the force exerted by the jet on the vane? [8M]

UNIT-V

9 a) How does the Kaplan turbine work, and how is its efficiency affected by its hydraulic design and the use of a draft tube? [7M]

b) A hydropower installation has a surge tank with a volume of 1000 m^3/s and a maximum water level of 30 m above the turbine. If the turbine has a net head of 60 m and operates at a flow rate of 20 m^3/s, what is the maximum power output of the turbine and the minimum volume of the surge tank required? [7M]

Or

10 a) What is the governing mechanism of hydraulic turbines, and how is it used to control the speed and power output of the turbines? How do surge tanks affect the performance of the turbines? [7M]

b) A Francis turbine has a flow rate of 10 m^3/s and operates at a head of 50 m. If the efficiency of the turbine is 85%, what is the power output of the turbine and its specific speed? [7M]

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Answer any **FIVE** Questions, each Question from each unit
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UNIT-I

1 a) What is the dynamic equation for non-uniform flow? How is it derived? [7M]
b) A trapezoidal channel has a bottom width of 6 m, a side slope of 1:2 and a flow rate of 20 m^3/s. Determine the specific energy of the flow and the location of the hydraulic jump. [7M]

Or

2 a) What is rapidly varied flow? How is it different from gradually varied flow? [7M]
b) A trapezoidal channel has a discharge of 20 m^3/s and a slope of 1 in 2000. The channel has a Manning's roughness coefficient of 0.025. Calculate the hydraulic radius and the velocity of flow in the channel. [7M]

UNIT-II

3 a) What is the Chezy formula and how is it used in open channel flow calculations? [5M]
b) A rectangular channel with a width of 6 meters and a depth of 2 meters is carrying a discharge of 40 m^3/s. A hydraulic jump occurs due to a sudden change in the downstream slope. Determine the depth of flow at the toe of the jump if the bed slope of the channel is 0.003 and the Manning's roughness coefficient is 0.03. [9M]

Or

4 a) What is the Manning's roughness coefficient and how is it used in open channel flow calculations? [6M]
b) A rectangular channel with a width of 10 meters and a depth of 3 meters is carrying a discharge of 100 m^3/s. The channel bed slope is 0.002 and the Manning's roughness coefficient is 0.025. Determine the water surface profile using the direct step method for a horizontal slope condition. [8M]

UNIT-III

5 a) Describe the dynamic similarity in hydraulic models. What are the factors that influence dynamic similarity? [7M]
b) A model of a hydraulic system has a discharge of 100 liters per second and a head of 10 meters. If the prototype system has a discharge of 10 m^3/s and a head of 100 meters, what is the scale of the model system? [7M]

Or

6 a) What are the different types of hydraulic models used in engineering practice? Describe their applications. [7M]
b) A model of a river has a flow velocity of 1 m/s and a discharge of 10 liters per second. If the prototype river has a flow velocity of 5 m/s, what should be the discharge of the prototype river? [7M]
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UNIT-IV

7 a) Describe the effect of the angle of incidence of a jet on a flat vane. [7M]

b) A Pelton wheel is designed to operate with a water jet velocity of 30 m/s and a flow rate of 0.02 m^3/s. The wheel has a diameter of 1 meter and is equipped with 20 buckets. If the efficiency of the wheel is 80%, what is the power output of the wheel? [7M]

Or

8 a) Explain the hydrodynamic force of jets on stationary and moving vanes. [6M]

b) A centrifugal compressor is designed to deliver air at a pressure ratio of 3:1. The inlet pressure and temperature are 1 bar and 25°C, respectively. The compressor is designed to operate at a speed of 3000 rpm and has an efficiency of 75%. If the mass flow rate of air is 5 kg/s, what is the power required by the compressor? [8M]

UNIT-V

9 a) How are hydraulic turbines selected for a specific hydropower installation, and what are the performance characteristics that need to be considered? [7M]

b) A hydropower installation has a gross head of 100 m and a net head of 90 m. If the efficiency of the turbine is 90%, what is the available power output of the turbine? [7M]

Or [7M]

10 a) What are the different types of centrifugal pumps, and how are they classified based on their installation details, work done, and efficiencies? [7M]

b) A Pelton wheel has a diameter of 1 m and operates at a speed of 500 rpm. If the water jet has a velocity of 50 m/s and a flow rate of 0.5 m^3/s, what is the power output of the wheel and its efficiency? [7M]