Reg. No. : | E | N | G | G | T | R | E | E | . | C | O | M |

Question Paper Code : 30097

B.E./B.Tech. DEGREE EXAMINATIONS, APRIL/MAY 2023.

Fourth Semester

Civil Engineering

CE 3401 — APPLIED HYDRAULICS ENGINEERING

(Regulations 2021)

Time : Three hours | Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. What is the main difference between pipe flow and open channel flow?

2. What is specific energy in open channel flow, and how is it related to the depth of flow?

3. What are the two numerical methods commonly used for determining the water surface profile in gradually varied flows?

4. Define the term "critical depth" in open channel flow.

5. What is the difference between an impulse turbine and a reaction turbine?

6. Define specific speed.

7. What is the difference between gradual and rapid varied flow?

8. Define hydraulic jump and explain why it occurs.

9. What is NPSH in centrifugal pumps?

10. Define cavitation in pumps.

PART B — (5 × 13 = 65 marks)

11. (a) (i) Calculate the Specific energy, Critical depth and the velocity of the flow of 12 m^3 in cement lined rectangular channel 3.5m wide with 2 m depth of water. Is the given flow is sub critical or super critical. (7)

(ii) Explain the concept of specific force in open channel flow, and discuss how it is related to specific energy and the depth of flow. Use relevant equations and diagrams to support your answer. (6)

Or

(b) A rectangular open channel has a bottom width of 5 m and a side slope of 1:2. The channel carries a discharge of 12 m^3/s of water. The Manning roughness coefficient for the channel is 0.025. Determine the critical depth, the velocity of flow, the specific energy, and the Froude number at a section where the depth of flow is 3m. Also, calculate the average velocity of flow and the wetted perimeter at this section. Finally, determine the best hydraulic section for uniform flow, and calculate the depth and velocity of flow in this section. Assume that the channel is made of concrete, with a Manning roughness coefficient of 0.013.

12. (a) Explain the dynamic equations of gradually varied flows and the concept of hydraulic slope.

Or

(b) A rectangular open channel has a bottom width of 6 m and a slope of 0.001. The channel carries a discharge of 10 m^3/s of water. The channel has a sudden drop in elevation over a distance of 15 m. Calculate the velocity of flow and coefficient of discharge.

13. (a) Explain the momentum equation and its application to rapidly varied flows. Discuss the assumptions and limitations of the momentum equation.

Or

(b) A rectangular channel with a bottom width of 4 meters and a slope of 0.005 has a discharge of 20 cubic meters per second. Determine the critical depth, the downstream depth, and the length of the hydraulic jump that will form.

14. (a) (i) Describe the different types of nozzles used in Pelton turbines and explain their significance. (5)

(ii) Derive an expression for the power output of the Pelton wheel turbine in terms of the jet velocity and the bucket geometry. (8)

Or

(b) (i) Discuss the advantages and limitations of Francis turbines compared to other types of turbines. (5)

(ii) A Francis turbine has a runner diameter of 1 meter and a flow rate of 0.3 m^3/s. The turbine operates with a head of 20 meters and an efficiency of 85%. Determine the power output of the turbine in kilowatts and the specific speed of the turbine. Also, sketch the head-flow curve of the turbine and discuss the concept of the runaway speed. (8)

15. (a) (i) Discuss the operating characteristics of centrifugal pumps, including the head-discharge curve and the efficiency curve. (5)

(ii) Explain the factors that affect the performance of centrifugal pumps and how they can be improved. (8)

Or

(b) (i) Describe the components and working principles of a reciprocating pump. (8)

(ii) Discuss the phenomenon of negative slip and its effect on pump performance. (5)

PART C — ($1 \times 15 = 15$ marks)

16. (a) A rectangular channel with a width of 5 meters and a depth of 2 meters is carrying a discharge of 25 m^3/s. The channel then encounters a sudden expansion, increasing the width of the channel to 10 meters. The water surface profile downstream of the expansion is a rapidly varied flow, and a hydraulic jump is formed. Calculate the critical depth and the velocity of flow before the jump.

Or

(b) A centrifugal pump is used to lift water from a well with a suction pipe length of 10 meters and a suction lift of 3 meters. The pump has an impeller diameter of 0.5 meters and is driven by an electric motor with a speed of 1450 rpm. The discharge pipe is 80 meters long and has a diameter of 0.25 meters. The pump has an NPSHr of 2 meters and a head-discharge curve as shown below :

Head (m)	Discharge (m^3/s)
45	0
40	0.03
35	0.06
30	0.09

Head (m)	Discharge (m^3/s)
25	0.12
20	0.15
15	0.18
10	0.21
5	0.24
0	0.27

Determine the operating point of the pump and the actual discharge, head, and efficiency of the pump. Also, determine the NPSHA and discuss the phenomenon of cavitation in pumps.
