



B.E DEGREE EXAMINATIONS: APRIL / MAY 2024

(Regulation 2018)

Fourth Semester

CIVIL ENGINEERING

U18CEI4201: Applied Hydraulics and Hydraulic Machinery

COURSE OUTCOMES

- CO1:** Design most economical section for an open channel
CO2: Analyse critical flow condition in channels
CO3: Determine GVF profiles
CO4: Select appropriate type of turbines for the given conditions
CO5: Assess the characteristics of pumps and turbines

Time: Three Hours

Maximum Marks: 100

Answer all the Questions:-
PART A (10 x 2 = 20 Marks)
(Answer not more than 40 words)

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| 1. Why is it important to optimize the channel design as most economical. | CO1 | [K ₂] |
| 2. Classify the types of open channel. | CO1 | [K ₁] |
| 3. Define Specific energy and draw the specific energy curve. | CO2 | [K ₂] |
| 4. What is meant by alternate depth? | CO2 | [K ₁] |
| 5. Based on the value of slope of free water surface, how will you classify the water surface profile | CO3 | [K ₂] |
| 6. Define afflux. | CO3 | [K ₁] |
| 7. Differentiate impulse turbine and reaction turbine. | CO4 | [K ₂] |
| 8. List the types of turbine according to direction of flow through runner | CO4 | [K ₁] |
| 9. Define breaking jet. | CO5 | [K ₁] |
| 10. State the use of priming and how is it done? | CO5 | [K ₂] |

Answer any FIVE Questions:-
PART B (5 x 4 = 20 Marks)
(Answer not more than 80 words)

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| 11. Derive the conditions for designing the most economical rectangular channel? | CO1 | [K ₃] |
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12. Find the rate of change of depth of water in a rectangular channel of 10m wide and 1.5m deep, when the water is flowing with a velocity of 1m/s. The flow of water through the channel of bed slope is 1 in 4000 is regulated in such a way that energy line is having a slope of 0.00004. CO2 [K₃]
13. Classify Water Surface profile based on the bed slopes and sketch the region of occurrence of flow profiles. CO3 [K₂]
14. Based on Head and Specific Speed conditions. how will you choose an appropriate turbine for designing a hydroelectric power plant. CO4 [K₃]
15. A reaction turbine works at 450rpm under a head of 120m. Its diameter at inlet is 120cm and flow area is 0.4m². The angles made by absolute and relative velocities at inlet are 200 and 600 respectively, with the tangential velocity. Determine i) Volume flow rate ii) the power developed iii) The hydraulic efficiency η_h . Assume whirl at outlet is zero. CO5 [K₃]
16. A single acting reciprocating pump running at 50 r.p.m. delivers 0.01 m³/s of water. The diameter of piston is 200mm and stroke length in 400mm. Determine i) The theoretical discharge of pump ii) Co-efficient of discharge iii) Slip and the percentage slip of pump. CO5 [K₃]

Answer any FIVE Questions:-
PART C (5 x 12 = 60 Marks)
(Answer not more than 300 words)

17. a) A concrete lined circular channel of diameter 3m has a bed slope of 1 in 500. Calculate the velocity and flow rate for the conditions of i) maximum velocity and ii) maximum discharge. Assume Chezy's C= 50. 6 CO1 [K₃]
- b) Find the diameter of a circular sewer pipe which is laid at a slope of 0.000125 and carries a discharge of 0.8 m³/s, when flowing half full. Take N = 0.020. 6 CO1 [K₃]
18. a) The discharge of water through a rectangular channel of width 6m, is 18m³/s when depth of flow of water is 2m. Calculate
i) specific energy of the flowing water
ii) critical depth and critical velocity and
iii) value of the minimum energy. 6 CO2 [K₃]
- b) The specific energy for a 6m wide rectangular channel is to be 5 kg-m/k. If the rate of flow of water through the channel is 24m³/s, determine the alternate depth of flow. 6 CO2 [K₃]

19. a) A discharge of 1000 lt/s flows along a rectangular channel, 1.5 m wide. What would be the critical depth in the channel? If a standing wave is to be formed at a point where the upstream depth is 180mm, what would be the rise in the water level? 6 CO3 [K₃]
- b) A rectangular channel 10m wide carries a discharge of 30 cumecs. It is laid at a slope of 0.0001. If at a section in the channel the depth is 1.6m, how far is the upstream or downstream from the section will the depth be 2m. Assume $N = 0.015$. Use direct step method for profile computation. 6 CO3 [K₃]
20. a) A pelton wheel is to be designed for the following specifications. Power = 735.75kW Shaft power, Head = 200m, Speed = 800 r.p.m, overall efficiency = 0.86 and jet diameter is not to exceed one tenth the wheel diameter. Take $C_v = 0.98$ and speed ratio = 0.45. Determine:
 i) Wheel diameter,
 ii) Number of jets required and
 iii) Diameter of the jet. 6 CO4 [K₃]
- b) The following data is given for a Francis turbine: net head = 70m, speed = 600 r.p.m, shaft power = 367.875kW, overall efficiency = 85% hydraulic efficiency = 95%, flow ratio = 0.25, breadth ratio = 0.1, outer diameter of the runner = 2 x inner diameter of runner. The thickness of vane occupies 10% of the circumferential area of the runner. Velocity of flow is constant at inlet and outlet and discharge is radial at outlet. Determine:
 i) Guide blade angle,
 ii) Runner vane angle at inlet and outlet,
 iii) Diameter of runner at inlet and outlet
 iv) Width of wheel at inlet. 6 CO4 [K₃]
21. a) Describe briefly on the classification of Hydraulic Turbines: 6 CO5 [K₂]
- b) A single acting reciprocating pump has a cylinder of diameter 150mm and stroke length 300mm. The center of the pump is 4m above the water surface in the sump. 6 CO5 [K₃]

The atmospheric pressure head is 10.3m of water and the pump is running at 40 r.p.m. If the length and diameter of the suction pipe are 5m and 10cm respectively. Determine the pressure head due to acceleration in the cylinder

- i) At the beginning of the suction stroke and
- ii) In the middle of the suction stroke.

22. a) An open channel of the most-economical section, having the form of a half hexagon with horizontal bottom is required to give a maximum discharge of 20.3 cumecs of water. The slope of the channel bottom is 1 in 2500. Take Chezy's constant, $C = 60$ in Chezy's equation, determine the dimensions of the cross-section. 6 CO1 [K₃]
- b) The discharge in a channel with bottom width 3 m is $12 \text{ m}^3/\text{s}$. If Manning's n is 0.013 and the streamwise slope is 1 in 200, find the normal depth if:
(a) the channel has vertical sides (i.e. rectangular channel) and
(b) the channel is trapezoidal with side slopes 2H:1V 6 CO1 [K₃]
