

Reg. No. \_\_\_\_\_

Name: \_\_\_\_\_

**APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY**  
FOURTH SEMESTER B.TECH DEGREE EXAMINATION, JUNE 2017

Course Code: **CE206**Course Name: **FLUID MECHANICS II (CE)**

Max. Marks: 100

Duration: 3 Hours

**PART A**

*Answer any 2 questions. Each question carries 15 marks.*

1. 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 1.75 m. The guide blade angle at the inlet at the extreme edge of the runner is  $35^\circ$ . The hydraulic and the overall efficiencies of the turbines are 88% and 84% respectively. If the velocity of whirl is zero at the outlet, determine:
  - a) Runner vane angles at the inlet and outlet at the extreme edge of the runner.
  - b) Speed of the turbine.
2. a. Show that the force exerted by a fluid jet in its direction of flow on a semicircular vane is twice that exerted on a flat vertical plate, both plates being fixed in position. (9)  
b. What are the different types of draft tubes? (6)
3. A centrifugal pump having outer diameter equal to two times the inner diameter and running at 1000 rpm works against a total head of 35 m. The velocity of flow through the impeller is constant and equal to 2.4 m/s. The vanes are set back at an angle of  $40^\circ$  at outlet. If the outer diameter of the impeller is 500 mm and width at outlet is 50 mm, determine:
  - i) Vane angle at inlet
  - ii) Work done by impeller on water per second, and
  - iii) Manometric efficiency.

**PART B**

*Answer any 2 questions. Each question carries 15 marks.*

4. a. Derive Chezy's equation for uniform flow in a channel section. (8)  
b. For a constant specific energy of 2.4 N.m/N, calculate the maximum discharge that may occur in a rectangular channel of 4.0 m wide. (7)
5. a. Explain the velocity distribution in an open channel. (5)

- b. A trapezoidal irrigation channel, having side slopes 3 horizontal to 2 vertical, is to carry a flow of 10 cumecs on a longitudinal slope of 1 in 5000. The channel is to be lined for which the value of Manning's coefficient is 0.012. Find the dimensions of the most economic section of the channel. (10)
6. Derive the expression for conjugate depths and energy loss associated with hydraulic jump in rectangular channels.

### PART C

*Answer any 2 questions. Each question carries 20 marks.*

7. a. Derive the dynamic equation of gradually varied flow in a channel, stating the assumptions involved. (10)
- b. A rectangular channel of 8.0 m wide has a uniform depth of flow of 2.0 m and has a bed slope of 1 in 3000. If due to weir constructed at the downstream end of the channel, water surface at a section is raised by 0.5m, determine the water surface slope with respect to horizontal at this section. Assume Manning's  $n = 0.02$ . (10)
8. a. Explain, with sketches, the various surface profiles that are possible in an open channel. (12)
- b. Derive the equation for the computation of length of backwater curve by step method. (8)
9. For laminar flow in a pipe, the pressure drop  $\Delta P$  in pipe of diameter  $D$  and length  $L$  depends on the density  $\rho$  and viscosity  $\mu$  of the flowing fluid, mean velocity of flow  $V$  and the average height of surface roughness of pipe ( $t$ ). Show by Rayleigh's method, the pressure drop  $\Delta P$  is given by

$$\Delta P = \rho V^2 f[(L/D) (t/D) (\mu/\rho V D)] \quad (20)$$

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**Total Pages: 2**

Reg No.: \_\_\_\_\_

Name: \_\_\_\_\_

**APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY**  
**FOURTH SEMESTER B.TECH DEGREE EXAMINATION, JULY 2017**

**Course Code: CE206**

**Course Name: FLUID MECHANICS II (CE)**

Max. Marks: 100

Duration: 3 Hours

**PART A**

*Answer any two full questions. Each question carries 15 marks.*

- 1 a) Derive the expression for work done by the jet per second on a moving flat plate. (5)
- b) A Pelton wheel has a mean bucket speed of 15 m/s and is supplied with water at a rate of  $0.850 \text{ m}^3/\text{s}$  under a head of 40m. If the bucket deflects the jet through an angle of  $150^\circ$ , find the power developed by the turbine and its hydraulic efficiency. Take the coefficient of velocity as 0.98. Neglect friction in the bucket. Also determine the overall efficiency of the turbine if its mechanical efficiency is 78%. (10)
- 2 a) Compare the velocity triangles for a Francis turbine and that of a Centrifugal pump. (5)
- b) A jet of water moving at 18 m/s impinges on a symmetrical curved vane shaped to deflect the jet through  $120^\circ$ . If the vane is moving at 4m/s, find the angle of the jet so that there is no shock at inlet. Also calculate the work done per unit weight of water. (10)
- 3 a) What is priming of a centrifugal pump. Why is it necessary? (5)
- b) A centrifugal pump delivers water against a net head of 15m and a design speed of 1200 rpm. The vanes are curved back at an angle of  $30^\circ$  with the periphery. The impeller diameter at the outlet is 300mm and the outlet width is 60mm. Determine the discharge of the pump if manometric efficiency is 96%. Assume outflow as radial at outlet. (10)

**PART B**

*Answer any two full questions. Each question carries 15 marks.*

- 4 a) Compare Open channel flow and pipe flow. (5)
- b) A flow of 150 litres per second flows through a rectangular flume of width 0.5m and having adjustable bottom slope. If Chezy's constant, C is 50, determine the bottom slope necessary for uniform flow with a depth of 0.4m. Also determine the conveyance and state of flow. (10)
- 5 a) What is meant by most economical section of an open channel? Enumerate the conditions for rectangular and trapezoidal channel to be most economical. (5)
- b) Draw the specific energy diagram showing critical point where the specific energy is minimum. Prove that  $E_{\min} = (3/2) y_c$  for a rectangular channel section, where  $y_c$  is the critical depth. (5)
- c) A 4m wide rectangular channel discharges  $16 \text{ m}^3/\text{s}$  of water at a depth of 3m. Calculate (5)
  - (i) specific energy (ii) critical depth (iii) minimum specific energy.

- 6 a) Define hydraulic jump. What are the practical applications of a hydraulic jump? (5)  
 b) A horizontal rectangular channel 3.5m wide carries discharge of 15m<sup>3</sup>/s. Check (10)  
 whether a jump may occur at an initial depth of 0.55m or not. If a jump occurs,  
 determine the sequent depth to this initial depth. Also calculate the energy loss in  
 the jump.

**PART C**

*Answer any two full questions. Each question carries 20 marks*

- 7 a) Derive the dynamic equation for gradually varied flow. (8)  
 b) Assuming that the rate of discharge Q of a centrifugal pump is dependent upon the (12)  
 mass density  $\rho$  of the fluid, pump speed N (rpm), diameter of the impeller D, the  
 pressure p and the viscosity of fluid  $\mu$ , show using the Buckingham's  $\pi$  theorem  
 that it can be represented by

$$Q = (ND^3) \phi [(gH/N^2D^2), (\nu/ND^2)]$$

Where H= head and  $\nu$ = kinematic viscosity of the fluid, g = acceleration due to gravity.

- 8 a) Sketch the water surface profiles occurring in mild slope channel and steep slope (10)  
 channel.  
 b) Design a concrete lined channel to carry a discharge of 500m<sup>3</sup>/s at a slope of 1 in (10)  
 4000. The side slopes of the channel may be taken as 1:1. The Manning's roughness  
 coefficient for the lining is 0.014. Assume permissible velocity in the section as  
 2.5m/s.
- 9 a) What is dimensional homogeneity? (4)  
 b) A 1:10 scale model of a passenger car is tested in a wind tunnel. The prototype (10)  
 velocity is 40kmph. If the model drag is 350N, what is the drag and the power  
 required to overcome the drag in the prototype. Assuming the air in the model and  
 prototype to have the same properties.  
 c) Explain the different types of similarities. (6)

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Reg No.: \_\_\_\_\_

Name: \_\_\_\_\_

**APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY**  
**FOURTH SEMESTER B.TECH DEGREE EXAMINATION, APRIL 2018**

**Course Code: CE206**

**Course Name: FLUID MECHANICS II (CE)**

Max. Marks: 100

Duration: 3 Hours

**PART A**

*Answer any two full questions, each carries 15 marks.*

Marks

- |   |  |     |
|---|--|-----|
| 1 | a) Explain the functions of draft tube.  | (4) |
|   | b) List down the classification of turbines.   | (3) |
|   | c) A jet of water 75 mm diameter having a velocity of 20 m/s strikes normally a flat smooth plate. Determine the thrust on the plate if:<br>i) if the plate is at rest<br>ii) if the plate is moving in the same direction as the jet with a velocity of 5 m/s. Also find the work done per second on the plate in each case and the efficiency of jet when the plate is moving  | (8) |
| 2 | a) What do you mean by specific speed of a centrifugal pump?   | (3) |
|   | b) Obtain an expression for minimum speed to start a centrifugal pump.   | (8) |
|   | c) Explain cavitation in centrifugal pump.   | (4) |
| 3 | a) Derive an expression for hydraulic efficiency of a Pelton wheel.  | (7) |
|   | b) A centrifugal pump having outer diameter equal to two times the inner diameter and running at 1200 rpm works against a total head of 48m. The velocity of flow through the impeller is constant and equal to 3m/s. The vanes are set back at an angle of $40^\circ$ at outlet. If the outer diameter of the impeller is 500 mm and width at outlet is 50mm, determine the vane angle at inlet, work done by impeller on water per second and manometric efficiency. | (8) |

**PART B**

*Answer any two full questions, each carries 15 marks.*

- |   |  |     |
|---|--|-----|
| 4 | a) Define Conveyance of a channel section.   | (2) |
|   | b) Write a short note on velocity distribution in open channels.   | (5) |
|   | c) A circular drainage pipe 0.8m in diameter conveys a discharge at a depth of 0.3m. If the pipe is laid on a slope of 1 in 1000, estimate the discharge. $N=0.02$ .   | (8) |
| 5 | a) Define section factor for critical flow.  | (3) |
|   | b) What are the applications of hydraulic jump?  | (4) |
|   | c) Obtain an expression for energy loss due to a hydraulic jump in horizontal rectangular channels.  | (8) |
| 6 | a) Prove that the most economical trapezoidal section is a half hexagon.   | (7) |
|   | b) A 3m wide rectangular channel carries a total discharge of $12 \text{ m}^3/\text{s}$ . Calculate:<br>i) the critical depth      ii) the minimum specific energy<br>iii) the alternate depths when $E = 4 \text{ m}$ . | (8) |

**PART C**

*Answer any two full questions, each carries 20 marks.*

- 7 a) With neat sketches explain the classification of water surface profiles. (10)  
b) Design a lined canal to carry  $100 \text{ m}^3/\text{s}$  on a slope of 1 in 2500. The maximum permissible velocity is 2 m/s,  $N=0.013$  and side slope is 1.25 H to 1 V. (10)
- 8 a) Differentiate between distorted models and undistorted models. (4)  
b) Obtain scale ratios for time, acceleration, force and power based on Froude model law. (6)  
c) Define the following: (3)  
i) Mach Number ii) Weber number iii) Euler's number
- d) A pipe of diameter 1.5 m is required to transport an oil of specific gravity 0.90 and viscosity  $3 \times 10^{-2}$  poise at a rate of 3000 litre/s. Tests were conducted on a 15cm diameter pipe using water at  $20^\circ\text{C}$ . Find the velocity and rate of flow in the model. Viscosity of water at  $20^\circ\text{C} = 0.01$  poise. (7)
- 9 a) The frictional torque  $T$  of a disc of diameter  $D$  rotating at a speed of  $N$  in a fluid of viscosity  $\mu$  and density  $\rho$  in a turbulent flow is given by  $T=D^5N^2 \rho\phi(\mu/D^2N\rho)$ . (10)  
b) A trapezoidal channel having bottom width 6m, side slope 2H to 1 V,  $N=0.025$  and bottom slope 0.0016 carries a discharge of  $10 \text{ m}^3/\text{s}$ . Compute the back water profile created by a dam which backs up the water to a depth of 2m immediately behind the dam. Use the direct step method for computation. (10)

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Reg. No. \_\_\_\_\_

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**APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY**

FOURTH SEMESTER B.TECH DEGREE EXAMINATION, DECEMBER 2018

**Course Code: CE206****Course Name: FLUID MECHANICS -II.**

Max. Marks: 100

Duration: 3 Hours

*Answer any two Questions from each part.***PART A**

1. a) Derive an expression for maximum hydraulic efficiency of a Pelton wheel. (5)  
b) A jet of water having a velocity of 45m/s impinges without shock a series of vanes moving at 15m/s, the direction of motion of the vanes being inclined at  $20^{\circ}$  to that of the jet. The relative velocity at outlet is 0.9 of that at inlet, and the absolute velocity of the water at exit is to be normal to the motion of the vanes. Find: (a) vane angles at entrance and exit (b) work done on vanes per unit weight of water supplied by the jet; and (c) the hydraulic efficiency. (10)
2. a) Explain with figure the function of a surge tank in a hydroelectric plant. (5)  
b) Determine the overall efficiency of a Kaplan turbine developing 3000kW under a net head of 5m. It is provided with a draft tube with its inlet diameter 3m set 1.6m above the tail race level. A vacuum gauge connected to the draft tube indicates a reading of 5m of water. Assume draft tube efficiency as 78%. Neglect losses in the draft tube. (10)
3. a) Define the terms (i) Specific speed of a centrifugal pump and (ii) Net Positive Suction Head. (5)  
b) The diameter of an impeller of a centrifugal pump at the inlet and outlet are 36cm and 72cm respectively. The velocity of flow at outlet is 2.4m/s and the vanes are set back at angle of  $45^{\circ}$  at outlet. Determine the minimum starting speed if the manometric efficiency is 70%. (10)

**PART B**

4. a) Differentiate between (i) Gradually varied flow and rapidly varied flow, (ii) subcritical and supercritical flow. (6)  
b) A trapezoidal channel with side slopes of 2 horizontal : 1 vertical has to be designed to carry  $15 \text{ m}^3/\text{s}$  at a slope of 1/5000. Determine the dimensions of the efficient section. Manning's coefficient is 0.014. (9)
5. a) A rectangular channel 3.5m wide is laid on a slope of 0.0005. Calculate the normal depth of flow for a discharge of  $5 \text{ m}^3/\text{s}$  in this channel. The Manning's coefficient can be taken as 0.02. (7)

- b) On what slope should one construct a 3m wide rectangular channel (Manning's coefficient is 0.014) so that critical flow will occur at a normal depth of 1.2m? (8)
6. a) Differentiate between alternate depths and conjugate depths. (5)
- b) In a hydraulic jump on a horizontal rectangular channel the depth and Froude number before the jump are 0.2 m and 9 respectively. Estimate the energy loss and specific energy head at the end of the jump. (10)

### PART C

7. a) Sketch the water surface profiles that can occur in a steep slope channel. (7)
- b) In a rectangular channel 12 m wide and 3.6 m deep water is flowing with a velocity of 1.2 m/s. The bed slope of the channel is 1 in 4000. If flow of water through the channel is regulated in such a way that energy line is having a slope of 0.00004, find the rate of change of depth of water in the channel. (8)
- c) Differentiate between backwater curve and drawdown curve. (5)
8. a) The resisting force  $F$  of a plane during flight can be considered as dependent upon the length of aircraft  $L$ , velocity  $V$ , air viscosity  $\mu$ , air density  $\rho$  and bulk modulus of air  $K$ . Express the functional relationship between these variables and the resisting force using dimensional analysis. (8)
- b) The normal depth of flow of water, in a rectangular channel 1.5 m wide, is one metre. The bed slope of the channel is 0.0006 and Manning's roughness coefficient is 0.012. Find the critical depth. At a certain section of the same channel the depth is 0.92 m while at a second section the depth is 0.86 m. Find the distance between the two sections. (12)
9. a) Explain the different types of similarities to be ensured between the model and prototype. (5)
- b) Explain the Froude model law and Reynolds model law. (5)
- c) A model of rectangular pier 1.5m wide and 4.5m long in a river is built to a scale of 1: 25. The average depth of water in the river is 3m. The model was tested in a laboratory, where the velocity of flow was maintained constant at 1.65m/s. It was observed that the force acting on the model was 3.92 N and the height of the standing wave was 3.5cm. Determine for the prototype a) the corresponding speed, b) the force acting, c) the height of the standing wave at nose. (10)

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Reg No.: \_\_\_\_\_

Name: \_\_\_\_\_

**APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY**  
**FOURTH SEMESTER B.TECH DEGREE EXAMINATION(R&S), MAY 2019**

**Course Code: CE206**

**Course Name: FLUID MECHANICS II (CE)**

Max. Marks: 100

Duration: 3 Hours

Assume any missing data suitably.

**PART A**

*Answer any two full questions, each carries 15 marks.*

- |   |  | Marks |
|---|--|-------|
| 1 | a) Show that the maximum efficiency of a jet striking normally on a series of flat plates arranged over the periphery of a runner is 50 %.   | (5)   |
|   | b) A Kaplan turbine develops 15000 kW power at a head of 30 m. The diameter of the boss is 0.35 times the diameter of the runner. Assuming a speed ratio of 2, a flow ratio of 0.65 and an overall efficiency of 90 % calculate the diameter of the runner and the rotational speed.   | (7)   |
|   | c) Why the suction lift of a centrifugal pump cannot exceed a certain limit?   | (3)   |
| 2 | a) A jet of water having a velocity of 35 m/s impinges without shock on a series of vanes moving at 20 m/s. The jet angle at inlet is $30^\circ$ and jet angle at exit is $60^\circ$ . Find: (a) vane angles at entrance and exit (b) work done on vanes per unit weight of water supplied by the jet; and (c) the hydraulic efficiency. | (10)  |
|   | b) A Pelton turbine is to operate under a net head of 500 m at 420 rpm. If a single jet with diameter 18 cm is used, find the specific speed of the machine. Take $C_v$ as 0.98 and overall efficiency as 0.85.  | (5)   |
| 3 | a) Derive an expression for the specific speed of a centrifugal pump.  | (5)   |
|   | b) A centrifugal pump discharges $0.2 \text{ m}^3/\text{s}$ of water at a head of 25 m when running at a speed of 1400 rpm. The manometric efficiency is 80%. If the impeller has an outer diameter of 30 cm and width of 5 cm, determine the vane angle at the outlet.  | (7)   |
|   | c) Define the term, Net Positive Suction Head.   | (3)   |

**PART B**

*Answer any two full questions, each carries 15 marks.*

- |   |   |      |
|---|---|------|
| 4 | a) Define the terms: i) wetted Perimeter, ii) Hydraulic depth and iii) Hydraulic radius.  | (5)  |
|   | b) A trapezoidal channel discharging water at the rate of $150 \text{ m}^3/\text{s}$ is to be designed for most economical section. Find the bottom width of the channel and depth of | (10) |

water. The side slope is  $45^\circ$ . Take bed slope is 1 in 1000 and Chezy's constant as 50.

- 5 a) Derive the condition for maximum discharge for a given value of specific energy. (7)  
 b) In a hydraulic jump on a horizontal rectangular channel the Froude number before the jump is 10 and energy loss during the jump is 4 m. Find i) depths before and after the jump, ii) the discharge per unit width and iii) Froude no after the jump. (8)
- 6 a) Define the terms: i) conveyance of a channel section ii) normal depth. (5)  
 b) A rectangular channel has a width of 1.8 m and carries a discharge of  $1.8 \text{ m}^3/\text{s}$  at a depth of 0.2 m. Calculate i) specific energy ii) depth alternate to the existing depth and iii) Froude numbers at the alternate depths. (10)

### PART C

*Answer any two full questions, each carries 20 marks.*

- 7 a) Derive the dynamic equation for gradually varied flow, stating the assumptions involved. (8)  
 b) A trapezoidal channel with 6 m bottom width and side slope 2 horizontal to 1 vertical having a bed slope of 0.0016 carries  $10 \text{ m}^3/\text{s}$  of water. The dam along the way of the channel rises the water depth by 2 m behind the dam. Decide the nature of channel and type of profile of water. Take Manning's coefficient as 0.025 (12)
- 8 a) The resistance force  $F$  of a ship is a function of length  $L$ , velocity  $V$ , gravitational acceleration  $g$ , density  $\rho$  and viscosity  $\mu$ . Develop a functional relationship in terms of non-dimensional numbers using Buckingham  $\pi$  theorem. (10)  
 b) Explain the different types of similarities to be ensured between the model and prototype. (6)  
 c) Explain the Froude model law. (4)
- 9 a) Find the slope of free water surface of a rectangular stream 20 m wide at a section 3 m deep. The slope of the bed of stream is 1 in 5000. Total discharge is  $25 \text{ m}^3/\text{s}$ . Assume Chezy's constant  $C$  as 55. State whether water surface will fall or rise. (10)  
 b) A 1 : 5 scale model of a car is tested in wind tunnel. The velocity of prototype is 75 km/h. The model drag is 300 N. Find out the drag and power required for the prototype. The air used is same in model and prototype. (7)  
 c) Differentiate between backwater curve and drawdown curve. (3)

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Reg No.: \_\_\_\_\_

Name: \_\_\_\_\_

**APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY**  
FOURTH SEMESTER B.TECH DEGREE EXAMINATION(S), DECEMBER 2019

**Course Code: CE206**

**Course Name: FLUID MECHANICS II**

Max. Marks: 100

Duration: 3 Hours

Assume any missing data suitably.

**PART A**

*Answer any two full questions, each carries 15 marks.*

- |  | Marks |
|--|-------|
| 1 a) A Pelton wheel working under a head of 800 m develops 15 MW running at 600 rpm with an overall efficiency of 85%. The ratio of wheel diameter to jet diameter is 15, the coefficient of velocity for the nozzle is 0.97 and the speed ratio is 0.46. Determine the rate of flow, diameter of wheel and number of jets.  | (8)   |
| b) A jet of water having a velocity of 40 m/s strikes a curved vane, which is moving with a velocity of 20 m/s. The jet makes an angle of $30^\circ$ with the direction of motion of vane at inlet and leaves at an angle of $90^\circ$ to the direction of motion of vane at outlet. Determine the vane angles at inlet and outlet so that the water enters and leaves the vane without shock.        | (7)   |
| 2 a) A Francis turbine is running at 400 rpm when head available is 60 m. The inner and outer diameters are 50 cm and 100 cm respectively. The constant velocity of flow through the runner is 10 m/s and hydraulic efficiency is 80%. Determine the inlet and outlet runner blade angles.   | (8)   |
| b) What are the functions of a draft tube?   | (4)   |
| c) Define specific speed of a centrifugal pump.  | (3)   |
| 3 a) Define the terms: i) suction head, ii) delivery head, iii) static head, and iv) manometric head.  | (4)   |
| b) Why priming is necessary in centrifugal pumps?  | (2)   |
| c) The impeller of a centrifugal pump has an external diameter of 300 mm and internal diameter of 150 mm and it runs at 1200 rpm. The vanes at exit are set back at an angle of $30^\circ$ . If the velocity of flow is constant at 2 m/s, determine: i) the blade angle at the inlet, ii) the velocity and direction of water at outlet and iii) the head developed if manometric efficiency is 0.85. | (9)   |

**PART B**

*Answer any two full questions, each carries 15 marks.*

- |  |     |
|--|-----|
| 4 a) Derive Chezy's equation for uniform flow in open channel.   | (7) |
| b) It is required to convey $10 \text{ m}^3/\text{s}$ of water at a mean velocity of 1.25 m/s. Calculate the dimensions of the most efficient section of the channel whose shape is a) rectangular and b) trapezoidal channel of side slope $1/\sqrt{3}$ | (8) |

- 5 a) Draw and explain the specific energy curve. (7)
- b) In a hydraulic jump occurring in a rectangular horizontal channel the discharge per unit width is  $2.5 \text{ m}^2/\text{s}$  and the depth before the jump is  $0.25 \text{ m}$ . Estimate the sequent depth and the energy loss. (8)
- 6 a) Define the terms: i) alternate depths, ii) Normal Slope and iii) Hydraulic mean depth. (5)
- b) A rectangular channel  $2.5 \text{ m}$  wide has a specific energy of  $1.50 \text{ m}$  when carrying a discharge of  $6.48 \text{ m}^3/\text{s}$ . Calculate the alternate depths and corresponding Froude numbers. (10)

### PART C

*Answer any two full questions, each carries 20 marks.*

- 7 a) Sketch the water surface profiles that can occur in a mild slope channel. (8)
- b) A wide rectangular channel of width  $12 \text{ m}$  conveys water at a normal depth of  $1.8 \text{ m}$ , the bed slope being 1 in 1800. Due to an obstruction in the form of an overflow dam the water level near the obstruction rises by  $1 \text{ m}$ . Find the slope of the water surface near the obstruction with respect to horizontal. Take Manning's coefficient as  $0.025$ . (12)
- 8 a) State Buckingham  $\pi$  theorem. (3)
- b) Explain the different types of similarity that must exist between a prototype and its model. (7)
- c) The variables controlling the motion of a floating vessel through water are the drag force  $F$ , the speed  $V$ , the length  $L$ , the density  $\rho$ , dynamic viscosity  $\mu$  of water and acceleration due to gravity  $g$ . Derive an expression for drag force  $F$  by dimensional analysis. (10)
- 9 a) A 1: 10 model of a channel is made for the purpose of studying wave motion. Find the scale ratios for (i) velocity, (ii) time and (iii) acceleration. If in the model a wave takes  $5$  second to travel a distance, find the time taken for the wave in the prototype to describe the corresponding distance. (8)
- b) Differentiate between distorted model and undistorted model with examples. (6)
- c) State the assumptions made in the derivation of the dynamic equation for gradually varied flow (6)

Reg No.: \_\_\_\_\_

Name: \_\_\_\_\_

**APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY**

Fourth semester B.Tech examinations (S), September 2020

**Course Code: CE206****Course Name: FLUID MECHANICS II (CE)**

Max. Marks: 100

Duration: 3 Hours

**PART A***Answer any two full questions, each carries 15 marks.*

Marks

- 1 a) Find the type of the turbine which should be used under a head of 150 m to develop 1500 KW while running at 300 rpm, based on specific speed criteria. (3)
- b) A jet of water strikes on a smooth stationary curved plate at the centre. Derive an equation for force exerted in the direction of the jet. (3)
- c) A Kaplan turbine, operating under a head of 20 m develops 20000 KW with an overall efficiency of 66%. The speed ratio is 2 and flow ratio is 0.6. The hub diameter of the wheel is 0.35 times the outer diameter of the wheel. Find the diameter and speed of the turbine. (9)
- 2 a) How priming is carried out in small and large centrifugal pumps? What is self-priming pump? (3)
- b) A centrifugal pump delivers  $0.04 \text{ m}^3/\text{s}$  of water to a height of 20 m through a 15 cm diameter pipe which is 100 m long. Calculate the manometric head if the coefficient of friction is 0.15. (3)
- c) Derive an expression for specific speed of a centrifugal pump. (9)
- 3 a) Find the ratio of forces exerted by a jet of water in the direction of jet when it strikes normally (4)
- i) a smooth stationary flat plate
- ii) a smooth flat plate moving in the direction of the jet at one half of the velocity of the jet.
- b) Compare Kaplan turbine and Francis turbine. (4)
- c) A centrifugal pump is running at 1000 rpm. The outlet vane angle of the impeller is  $45^\circ$  and velocity of flow at outlet is 2.5 m/s. The discharge through the pump is 200 litres/s when the pump is working against a total head of 20m. (7)

If the manometric efficiency of the pump is 80%, determine the diameter of the impeller and the width of the impeller at the outlet.

**PART B**

*Answer any two full questions, each carries 15 marks.*

- 4 a) Differentiate between hydraulic radius and hydraulic depth. (3)
- b) A triangular channel has a side slope of 1.5 horizontal to 1 vertical and is laid on a longitudinal slope of 1 in 1650. Assuming Manning's coefficient as 0.013, estimate the normal depth required to pass a discharge of  $0.3 \text{ m}^3/\text{s}$ . (3)
- c) A trapezoidal section has side slopes of 1 vertical to 1 horizontal and has to carry a discharge of  $14 \text{ m}^3/\text{s}$ . The bed slope of the channel is 1 in 1000. Chezy's constant is 45 if the channel is unlined and is 70 if the channel is lined with concrete. The cost per cubic meter of excavation is 3 times the cost per square metre of lining. The channel is to be the most efficient one. Find whether the lined canal or unlined canal will be cheaper. (9)
- 5 a) List out any three practical cases in which a hydraulic jump may occur. (3)
- b) Explain specific force curve. (3)
- c) A discharge of  $18 \text{ m}^3/\text{s}$  flows through a rectangular channel 6m wide at a depth of 1.6m. Find the specific energy and critical depth. State whether the flow is subcritical or supercritical. What is the alternate depth? (9)
- 6 a) Show that the head loss in a hydraulic jump formed in a rectangular channel may be expressed as  $\Delta E = \frac{(V_1 - V_2)^3}{2g(V_1 + V_2)}$  (8)
- b) For maximum discharge in a circular channel section, prove that the depth of flow is 0.95 times the diameter of the channel. (7)

**PART C**

*Answer any two full questions, each carries 20 marks.*

- 7 a) What are the assumptions made for deriving dynamic equation for gradually varied flow? (5)
- b) A rectangular channel 10 m wide carries a discharge of  $10 \text{ m}^3/\text{s}$ . It is laid at a slope of 0.0001. If the depth of flow at a section is 1.6 m, how far (upstream or downstream) will be the depth be 2 m? Manning's coefficient  $N = 0.015$ . (15)
- 8 a) Distinguish between Reynolds number and Froude number. (5)
- b) What is distorted model? What are the merits and demerits? (5)
- c) The efficiency  $\eta$  of a fan depends upon the kinematic viscosity of the fluid  $\mu$ , the angular velocity  $\omega$ , diameter  $D$  of the rotor and the discharge  $Q$ . Express  $\eta$  (10)

in terms of dimensionless parameters using Buckingham  $\pi$ - theorem as

$$\eta = \varphi \left[ \frac{v}{\omega D^2}, \frac{Q}{\omega D^3} \right].$$

- 9 a) Find the slope of free water surface in a rectangular channel of width 3 m and depth of flow 0.75 m. The discharge through the channel is  $0.84 \text{ m}^3/\text{s}$ . The bed of the channel is having a slope of 0.15 m per km. Assume Chezy's constant, C as 55. (5)
- b) With a neat sketch explain the characteristics of water surface profile in critical sloped channels. (5)
- c) A 1: 50 spillway model has a discharge of  $1.25 \text{ m}^3/\text{s}$ . 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? (10)

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