

Roll No.....

CE 406: Fluid Mechanics-II

Time: 3 hours

Max. Marks: 100

**Instructions to students:**

1. Do not write anything other than your roll number on question paper.
2. Assume suitable data wherever required and mention it clearly.
3. Writing appropriate units, nomenclature, and drawing neat sketches/schematics/ flow chart wherever, required are an integral part of the answer.
4. Answer should be precise and to the point only

**Q.1A Objective type multiple choice questions (10 questions @ 1 mark)**

10

- i. In a submerged orifice flow, the discharge is proportional to which one of the following parameters?
  - (a) Square root of the downstream head
  - (b) Square root of the upstream head
  - (c) Square of the upstream head
  - (d) Square root of the difference between upstream and downstream heads
- ii. For a hydraulically efficient rectangular section the ratio of width to normal depth is
  - (a) 0.5
  - (b) 1.0
  - (c) 2.0
  - (d)  $2\sqrt{3}$
- iii. Coefficient of contraction is the ratio of
  - (a) actual velocity of jet at vena contracta to the theoretical velocity
  - (b) loss of head in the orifice to the head of water available at the exit of the orifice
  - (c) actual discharge through an orifice to the theoretical discharge
  - (d) area of jet at vena contracta to the area of orifice
- iv. The discharge over a rectangular notch is
  - (a) inversely proportional to  $H^{3/2}$
  - (b) directly proportional to  $H^{3/2}$
  - (c) inversely proportional to  $H^{5/2}$
  - (d) directly proportional to  $H^{5/2}$
- v. A rectangular channel carries a uniform flow with a Froude number of 2.83. the ratio of critical depth to normal depth of this flow is .....
- vi. A sluice gate discharges water into a horizontal rectangular channel with a velocity of 12 m/s and depth of flow of 1 m. What is the depth of flow after the hydraulic jump?
  - (a) 6.42 m
  - (b) 5.84 m
  - (c) 4.94 m
  - (d) 2.21 m
- vii. A standard 90° V-notch weir is used to measure discharge. The discharge is  $Q_1$  for heights  $H_1$  above the sill and  $Q_2$  is the discharge for a height  $H_2$ —  
If  $H_2 / H_1$  is 4, then  $Q_2 / Q_1$  is:
  - (a) 32
  - (b)  $16\sqrt{2}$
  - (c) 16
  - (d) 8



- viii. A fluid jet is discharging from a 100 mm nozzle and the vena contracta formed has a diameter of 90 mm. If the coefficient of velocity is 0.95, then the coefficient discharge for the nozzle is:  
 (a) 0.855 (b) 0.81 (c) 0.9025 (d) 0.7695
- ix. If the number of fundamental dimensions equals 'm', then the repeating variables shall be equal to:  
 (a) m and none of the repeating variables shall represent the dependent variable.  
 (b) m + 1 and one of the repeating variables shall represent the dependent variable  
 (c) m + 1 and none of the repeating variables shall represent the dependent Variable.  
 (d) m and one of the repeating variables shall represent the dependent variable.
- x. In flow through a pipe, the transition from laminar to turbulent flow does not depend on  
 (a) Velocity of the fluid (b) Density of the fluid  
 (c) Diameter of the pipe (d) Length of the pipe
- Q.2 Short answer type questions (4 questions @ 2.5 marks) 10
- i. Explain with the help of neat sketch :  
 (i) Steep slope profile (ii) Adverse slope profile
- ii. Determine the two depth having specific energy of 1.83 m for 2.80 m<sup>3</sup>/s-m.
- iii. Define the velocity distribution in open channel with diagram.
- iv. Determine the critical depth of a rectangular channel of width 4.0 m and discharge of 12 m<sup>3</sup>/s.
- Q.3A Explain the term hydraulic jump .Derive an expression for the depth of hydraulic jump in terms of the upstream Froude number. 05
- Q.3B Draw and explain the specific energy diagram for various constant and show the alternate and critical depth. 05
- Q.4A How are weir classified? Define velocity of approach .Derive an equation for discharge over a rectangular weir taking velocity of approach. 05
- Q.4B Find the slope of the free water surface in a rectangular channel of width 20 m having depth of flow 5 m. the discharge through the channel is 50 m<sup>3</sup> /s. The bed of the channel having a slope of 1 in 4000. Take the value of Chezy's constant C= 60. 05
- Q.5A Derive the differential equation for steady gradually varied flow in open channel and list all the assumptions: 05

$$\frac{dy}{dx} = \frac{S_b - S_o}{1 - \frac{Q^2 T}{g A^3}}$$

Q.5B State the chezy's, kutter and manning formulas for uniform flow through a channel .Differentiate between open channel flow and pipe flow. Why is bed slope provided in channels? 05

Q.6A Explain the term vena contracta as applied to flow through an orifice .Explain how it is developed? A tank 2.5 m high, standing on the ground is kept full of water .there is a small orifice in its vertical side with its center at depth  $h$  meter below the free surface of liquid in the tank. Find the value of  $h$  so that the liquid jet strike the ground at the maximum distance from the tank. Presuming  $C_v = 0.98$ , work out the maximum value of horizontal distance. 05

Q.6B State Buckingham's  $\pi$  theorem. What do you mean by repeating variable? Why this theorem is considered superior over the Rayleigh's method of dimension analysis. 05

OR

Q.6B A 1: 15 model of a flying boat is towed through water. The prototype is moving in sea water of density  $1024 \text{ kg/m}^3$  at a velocity of  $20 \text{ m/s}$ . find the corresponding speed of the model. Also determine the resistance due to waves on model if the resistance due to wave of prototype is  $600 \text{ N}$ . 05

Q.7A A tank has two identical orifice on one of its vertical sides. The upper orifice is  $3 \text{ m}$  below the water surface and lower one is  $5 \text{ m}$  below the water surface. If the value of  $C_v$  for each orifice is  $0.96$ , find the point of intersection of the two jets. 05

Q.7B Determine the height of a rectangular weir of length  $6 \text{ m}$  to be built across a rectangular channel. The maximum depth of water on the upstream side of the weir is  $1.8 \text{ m}$  and discharge is  $2000 \text{ liter/ sec}$ . Take  $C_d = 0.6$  and neglect end contraction. 05

OR

Q.7B A closed tank partially filled with water discharges through an orifice of  $12.5 \text{ mm}$  diameter and has a coefficient of discharge of  $0.65$ . If air is pumped into the upper part of the tank, Determine the pressure required to produce a discharge of  $36.6 \text{ liters/ minute}$  when the water surface is  $1 \text{ m}$  above the outlet. 05

Q.8A A triangular channel of apex angle  $90^\circ$  and a rectangular channel of the same material have the same bed slope. If the rectangular channel has the depth of flow equal to width of channel and flow areas in both channels are the same, find the ratio of discharges in rectangular and triangular channels respectively. Use Manning's Roughness equation for estimation of velocity. 10

Q.9A A trapezoidal channel has side slopes  $1$  to  $1$ . It is required to discharge  $13.75 \text{ m}^3/\text{s}$ . of water with a bed gradient of  $1$  in  $1000$ . If unlined the value of Chezy's  $C$  is  $44$ . If lined with concrete, the value is  $60$ . The cost per  $\text{m}^3$  of excavation is four times the cost per  $\text{m}^2$  of lining. The channel is to be the most efficient one. Find whether the lined canal or the unlined canal will be cheaper. What will be the dimension of that economical canal? 10

- Q.9B A cylinder 0.16m in diameter is to be mounted in a stream of water in order to estimate the force on a tall chimney of 1m diameter which is subject to wind of 33m/s. Calculate (A) the speed of the stream necessary to give dynamic similarity between the model and chimney, (b) the ratio of forces. 10

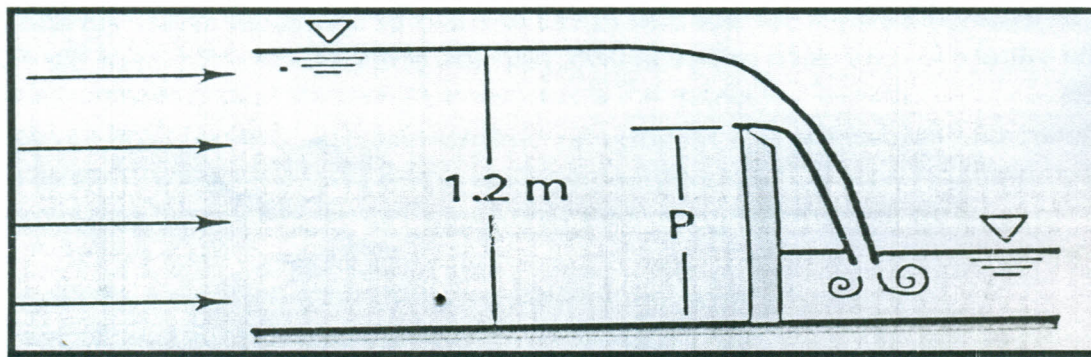
Chimney:  $\rho = 1.12 \text{ kg/m}^3$        $\mu = 16 \times 10^{-6} \text{ kg/ms}$   
 Model:  $\rho = 1000 \text{ kg/m}^3$        $\mu = 8 \times 10^{-4} \text{ kg/ms}$

Draw up the table of values you have for each variable:

| Variable | Water                            | Air                               |
|----------|----------------------------------|-----------------------------------|
| $v$      | $V_{\text{water}}$               | 33 m/s                            |
| $F$      | $F_{\text{water}}$               | $F_{\text{air}}$                  |
| $\rho$   | $1000 \text{ kg/m}^3$            | $1.12 \text{ kg/m}^3$             |
| $\mu$    | $8 \times 10^{-4} \text{ kg/ms}$ | $16 \times 10^{-6} \text{ kg/ms}$ |
| $d$      | 0.16m                            | 1m                                |

OR

Q.9B



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An engineer is considering the feasibility of a small hydroelectric power plant, and she wishes to design a rectangular weir to measure the discharge of a small creek. The weir will span creek, which is 1.5 m wide, and engineer estimates that the maximum discharge will be  $0.5 \text{ m}^3/\text{s}$  if the creek level cannot rise above 1.2m. Calculate the height of the weir.