

ECE 2203: FLUID MECHANICS
END OF SEMESTER EXAMINATION
SERIES: SEPT.
TIME: 2 HOURS

Instruction to Candidates

You should have the following for this examination.

Answer Booklet

This paper consists of **FIVE** questions.

Answer question ONE (Compulsory) and any other two questions.

Maximum marks for each part of a question are shown.

This paper consists **THREE** printed pages.

Question ONE (Compulsory – 30 Marks)

(a) Define the following parameters;

- (i) Pressure and indicate its units (2 marks)
- (ii) Hydrostatics (2 marks)
- (iii) Steady Uniform Flow (2 marks)
- (iv) Unsteady Non-Uniform Flow (2 marks)

(b) Show that the momentum equation for a steady flow over a region of uniform velocity is given by

$$F_x = \rho Q(V_{2x} - V_{1x}) \quad (7 \text{ marks})$$

(c) A frictionless siphon has its top point position denoted as A. From point A of the siphon to the water level (Point 1) is 2.40m. From the water level downwards to a point B is 1.20m. From point B downwards to the exit (Point 2) is 0.16m. Determine the discharge and the pressure heads at A and B, given that the pipe diameter is 200mm and the nozzle exit diameter is 150mm. (15 marks)

Question Two (20 Marks)

(a) A pump delivers water from a lower to a higher reservoir. The difference in elevation between the reservoirs is 12m. The pump provides an energy head of 14m and the frictional head losses are 1.2m. If the pipe diameter is 300mm, calculate the discharge. (5 marks)

(b) Calculate the magnitude and direction of the force exerted by a T-junction if the discharge are $Q_1=0.3\text{m}^3/\text{s}$, $Q_2=0.15\text{m}^3/\text{s}$, $Q_3=0.15\text{m}^3/\text{s}$, the diameters are $D_1=450\text{mm}$, $D_2=300\text{mm}$, $D_3=200\text{mm}$ and the upstream pressure $p_1=500\text{kN}/\text{m}^2$. (15 marks)

Question Three (20 Marks)

(a) A rock fill dam is inclined at angle of 45 degrees at the upstream side. The reservoir design depth is 10m.

Calculate

(i) The force on the dam per unit width (4 marks)

(ii) The location of the centre of pressure (6 marks)

(b) Find the magnitude and direction (angle) of the resultant force of water on a quadrant gate. The principal dimensions of the gate are:

Radius of gate = 1.0m

Width of gate = 3.0m

Water density = $1000\text{kg}/\text{m}^3$

The position of the centre of gravity is $4R/3\pi$ horizontally from the origin (10 marks)

Question Four (20 Marks)

(a) A horizontal pipe bends through 45 degrees in plan and reduces in diameter gradually from 500mm to 300mm through the bend. The pipe discharges to the atmosphere immediately after the bend at a velocity of 4m/s. Determine

(i) The magnitude of the total force (10 marks)

(ii) The direction exerted by the total force on the bend (5 marks)

(b) Derive the Continuity Equation

(5 marks)

Question Five (20 Marks)

If a hydrometer was a rod that had a length of 0.25m, cross sectional area was $2 \times 10^{-4} \text{ m}^2$, and mass of $4.5 \times 10^{-2} \text{ kg}$,

(i) How far from the bottom end of the rod should a mark of 1.000 be placed to indicate the relative density of water? (10 marks)

(ii) If the hydrometer sinks to a depth of 0.229m when placed into alcohol solution, what is the density of the alcohol solution (10 marks)