



MURANG'A UNIVERSITY OF TECHNOLOGY

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF MECHANICAL ENGINEERING

UNIVERSITY ORDINARY EXAMINATION

2024/2025 ACADEMIC YEAR

**THIRD YEAR FIRST SEMESTER EXAMINATION FOR BACHELOR OF
TECHNOLOGY IN MECHANICAL ENGINEERING**

EMT 302 – FLUID MECHANICS II

DURATION: 2 HOURS

INSTRUCTIONS TO CANDIDATES:

1. Answer question ONE and any other two questions.
2. Mobile phones are not allowed in the examination room.
3. You are not allowed to write on this examination question paper.

SECTION A – ANSWER ALL QUESTIONS IN THIS SECTION

QUESTION ONE (30 MARKS)

- a) Define dimensional Analysis. (2 marks)
- b) State four uses and advantages of dimensional analysis. (8 marks)
- c) Explain the term Dimensional Homogeneity. (2 marks)
- d) A jet of water, 75mm in diameter issues with a velocity of 30m/s and impinges on a stationary flat plate which destroys its forward motion. Find the force exerted by the jet on the plate and work done. (5 marks)
- e) Explain the water hammer Phenomenon. (3 marks)
- f) State four factors which the pressure rise due to water hammer depends. (4 marks)
- g) Estimate for a 1/20 model of a spillway.
 - i. The prototype velocity corresponding to a model velocity of 1.5m/s.
 - ii. The prototype discharge per unit width corresponding to a model discharge per unit width of $0.2\text{m}^3/\text{s}$ per metre. (6 marks)

SECTION B– ANSWER ANY TWO QUESTIONS IN THIS SECTION

QUESTION TWO (20 MARKS)

- a) Describe minor energy losses in pipes and give five causes. (6 marks)
- b) In a pipe of 300 mm diameter and 800 m length an oil of specific gravity 0.8 is flowing at the rate of $0.45\text{m}^3/\text{s}$ find:
 - i. Head lost due to friction
 - ii. Power required maintaining the flow (take the Kinematic viscosity of oil as 0.3 strokes). (6 marks)
- c) A horizontal pipe 150 mm in diameter is joined by sudden enlargement to a 255mm diameter pipe. Water is flowing through it at the rate of $0.5\text{m}^3/\text{s}$. Find
 - i. Loss of head due to abrupt expansion.
 - ii. Pressure difference in the two pipes.
 - iii. Change in pressure if the change of section is gradual without any loss. (8 marks)

QUESTION THREE (20 MARKS)

- a) Explain the following terms
- i. Turbulent boundary layer
 - ii. Laminar boundary layer (4 marks)
- b) Describe the following boundary layer thickness.
- i. Displacement thickness
 - ii. Momentum thickness
 - iii. Energy thickness (6 marks)
- c) The velocity distribution in the boundary layer is given by:

$$\frac{u}{U} = 2 \left(\frac{y}{\delta} \right) - \left(\frac{y^2}{\delta^2} \right)$$

Where u is the velocity at a distance y from the plate and $u=U$ at $y=\delta$ where δ boundary layer thickness. Find:

- i. The displacement thickness
- ii. The momentum thickness
- iii. The energy thickness (10 marks)

QUESTION FOUR (20 MARKS)

- a) Explain the following types of flow:
- i. Steady flow
 - ii. Uniform flow (4 marks)
- b) Show that the work done by a force exerted by a water jet on a moving plate inclined in the direction of the jet is given by:

$$F_x = \rho V^2 \sin^2 P$$

Where ρ = density, a = area of the jet

V = velocity of the jet

P = Inclination of the plate with the jet (8 marks)

- c) A nozzle of 60 mm diameter delivers a stream of water at 24m/s perpendicular to a plate that moves away from the jet at 6m/s. Calculate:
- i. The force on the plate
 - ii. The work done
 - iii. Efficiency of the jet. (8 marks)