



ALUPE UNIVERSITY

OFFICE OF THE DEPUTY VICE CHANCELLOR
ACADEMICS, RESEARCH AND STUDENTS' AFFAIRS

**UNIVERSITY EXAMINATIONS
2025/2026 ACADEMIC YEAR**

FOURTH YEAR FIRST SEMESTER REGULAR MAIN EXAMINATION

**FOR THE DEGREE OF BACHELOR OF EDUCATION
ARTS & SCIENCE**

COURSE CODE: MAT 417E

COURSE TITLE: FLUID MECHANICS

DATE: WEDNESDAY, 3/12/2025

TIME: 9AM-12PM

INSTRUCTION TO CANDIDATES

- SEE INSIDE
- THIS PAPER CONSISTS OF 3 PRINTED PAGES PLEASE TURN OVER

STREAM: CS

DURATION: 3 Hours

INSTRUCTION TO CANDIDATES

- Answer ALL questions from section A and any THREE from section B*
- Do not write on the question paper.*

SECTION A, COMPULSARY (31 MARKS)

QUESTION ONE (16 MARKS)

- a) Define the following fluid properties and state their engineering significance:
- i. Density (2 marks)
 - ii. Viscosity (2 marks)
 - iii. Surface tension (2 marks)
 - iv. Compressibility (2 marks)
- b) A rectangular plate of area 2.5 m^2 is immersed vertically in water such that the top edge is 1 m below the free surface. Calculate:
- i. The total hydrostatic force on the plate. (5 marks)
 - ii. The depth of the centre of pressure. (3 marks)

QUESTION TWO (15 MARKS)

- a) State and explain the principle of buoyancy. (3 marks)
- b) A solid block weighing 800 N has a volume of 0.12 m^3 . It is placed in water of density 1000 kg/m^3 . Determine:
- i. The buoyant force on the block. (5 marks)
 - ii. Whether the block will float or sink. (4 marks)
 - iii. If it floats, what fraction of its volume is submerged? (3 marks)

SECTION B, ANSWER ANY THREE QUESTIONS (39 MARKS)

QUESTION THREE (13 MARKS)

- a) Identify THREE common problems associated with fluid systems and suggest possible solutions. (3 marks)
- b) Distinguish between laminar flow and turbulent flow. (4 marks)
- c) Oil of viscosity 0.25 Ns/m^2 flows between two parallel plates 10 mm apart. The velocity at the mid-plane is 2 m/s. Calculate the shear stress at the plates. (6 marks)

QUESTION FOUR (13 MARKS)

- a) Write the Navier–Stokes equation for an incompressible fluid. Explain the physical meaning of each term. (6 marks)
- b) A water jet of velocity 25 m/s and diameter 50 mm strikes a flat plate held normal to the jet. Determine the thrust force on the plate. Take water density 1000 kg/m^3 (7 marks)

QUESTION FIVE (13 MARKS)

- a) Explain the significance of dimensionless numbers in fluid mechanics. (4 marks)
- b) Using Buckingham Pi theorem, show how the discharge Q over a sharp-edged rectangular weir depends on the head of water H , gravitational acceleration g , and weir width L . (5 marks)
- c) Briefly explain the concept of boundary layer separation and its effect on drag forces. (4 marks)

QUESTION SIX (13 MARKS)

- a) State Pascal's law. Give one real life example. (3 marks)
- b) Water flows through a horizontal pipe of diameter 200 mm at a velocity of 2.5 m/s. Determine the Reynolds number and state the nature of the flow. Take water density = 1000 kg/m^3 , viscosity = 0.001 Ns/m^2 . (10 marks)

QUESTION SEVEN (13 MARKS)

- a) Name two devices that work on the principle of Bernoulli's theorem. (2 marks)
- b) Why do aeroplanes fly according to fluid mechanics (3 marks)
- c) State the Archimedes' principle. (2 marks)
- d) Consider the flow velocity V of a fluid over a flat plate. The velocity depends on the plate length L , fluid density ρ , fluid viscosity μ , and the external force F . Derive the dimensionless groups using Buckingham π theorem. (6 marks)