



KISII UNIVERSITY
UNIVERSITY EXAMINATIONS

**FIRST YEAR EXAMINATION FOR THE AWARD OF
THE DEGREE OF MASTER OF SCIENCE APPLIED MATHEMATICS
FIRST SEMESTER 2021/2022
(JUNE-SEPTEMBER, 2022)**

MATH 850: FLUID MECHANICS I

STREAM: Y1S1

TIME: 3 HOURS

DAY: TUESDAY, 2.00 PM – 5.00 PM

DATE: 02/08/2022

INSTRUCTIONS:

- 1. Do not write anything on this question paper.**
- 2. Answer Section A (Compulsory) and Any Other TWO Questions**

SECTION A (30 MARKS)

1.

- Explain types of fluids, conservation laws giving examples in each case (5 marks)
- A perfect gas is expanded from 5 to 1 bar by the law $pV^{1.2} = C$. The initial temperature is 200°C . Calculate the change in specific gravity. Take $R = 287 \text{ J/kgK}$, $\gamma = 1.4$ (5 marks)
- Explain giving the numerical definitions of the following non-dimensional numbers in fluid mechanics
 - Reynolds number Re (5 marks)
 - Vorticity (5 marks)
- If the equation of a velocity profile over a plate is $v = y^3 + y$ (where v is the velocity in m/s) determine the shear stress at $y = 4$ and at $y = 3.5 \text{ cm}$. Given the viscosity of the liquid is 8.35 poise. (5 marks)
- The velocity components in a three-dimensional velocity field for an incompressible fluid are expressed as (5 marks)

$$u = \frac{y^3 z}{3} + 2xz - x^2 y$$
$$v = y^2 x - 2zy - \frac{x^3}{3}$$

$$w = z^2y - 2yz - \frac{x^3}{3}$$

Show that these functions represent a possible case of an irrotational flow.(5 marks)

2.

a. A plate having an area of 0.6m^2 is sliding down an inclined plane of 30° to the horizontal with a velocity of 0.36m/s . There is a cushion of fluid 1.8mm thick between the plane and the plate. Find the viscosity of the fluid if the weight of the plate is 280N . (10 marks)

b. A pitot tube is pointed into an air stream which has a pressure of 105 kPa . The differential pressure is 20 kPa and the air temperature is 20°C . Calculate the air speed. (10 marks)

3.

a. A flow field is described by the equation $\varphi = y - x^2$, Sketch the streamlines $\varphi = 0$, $\varphi = 1$, $\varphi = 3$. Derive an expression for the velocity V at any point in the flow field and calculate the vorticity. (10 marks)

b. Calculate the specific weight, specific mass, specific volume and specific gravity of a liquid having a volume of 6m^3 and weight of 44kN . (10 marks)

4.

a. A perfect gas is expanded from 5 to 1 bar by the law $pV^{1.2} = C$. The initial temperature is 200°C . Calculate the change in specific gravity. Take $R = 287\text{ J/kgK}$, $\gamma = 1.4$. (10 marks)

b. Obtain an expression in non-dimensional form for the pressure gradient in a horizontal pipe of circular cross-section. Show how this relates to the familiar expression for frictional head loss. (10 marks)

5.

a. State the Newton's Law of viscosity (10 marks)

b. A plate of 0.05mm distant from a fixed plate moves at 1.2m/s and requires a force of 2.2N/m^2 to maintain the speed. Find the viscosity of the fluid between the plates. (10 marks)