(Knowledge for Development)

KIBABII UNIVERSITY

UNIVERSITY EXAMINATIONS

2020/2021 ACADEMIC YEAR

FIRST YEAR FIRST SEMESTER

MAIN EXAMINATION

FOR THE DEGREE OF MASTER OF SCIENCE IN APPLIED MATHEMATICS

COURSE CODE: **MAT 864E**

COURSE TITLE: **: FLUID MECHANICS**

DATE: 14/10/21 **TIME:** 2 PM -5 PM

INSTRUCTIONS TO CANDIDATES

Answer Any THREE Questions

TIME: 3 Hours

This Paper Consists of 3 Printed Pages. Please Turn Over.

QUESTION ONE (20 MARKS)

(a) What is an initial force? (1Mk)

(b) Relate the three fundamental quantities and their dimensions. (3Mks)

(c) By use of initial forces and gravitational forces define the Froude number. (4Mks)

(d) Consider a small aeroplane with characteristic length of 10cm and characteristic speed U of 10^4 cm/s. find the Froude number (5Mks)

(e) Define a thermodynamic system. (3Mks)

(f) Use (e) above to explain internal energy. (3Mks)

QUESTION TWO (20 MARKS)

(a) Define an adiabatic process. (2Mks)

(b) Show that for an additional process for a perfect gas $V = constant\ X\ T^{\frac{-1}{(8-1)}}$ (10Mks)

(c) Explain a reversible process (5Mks)

(d) Using a specific example define a stagnation point. (3Mks)

QUESTION THREE (20MARKS)

An equation of our disturbance caused by an aerofoil moving at a steady speed U through an otherwise undisturbed air is given by $(1 - M^2)\frac{\partial^2 \emptyset}{\partial x^2} + \frac{\partial^2 \emptyset}{\partial y^2} = 0$

(i) Define the terms M and ϕ. (2Mks)

(ii) Discuss fully the cases below using the above equation

(a) Subsonic case (6Mks)

(b) Supersonic case (6Mks)

(c) Hypersonic case (6Mks)

QUESTION FOUR (20MARKS)

(a) What is Reynolds number (1Mk)

(b) Discuss (a) above if a characteristic length $L = 10^3 cm$ and a characteristics speed $U = 10^4 cm/s$ in aerodynamic s and in hydrodynamics if $L = 10^3 cm$ and $U = 10^4 cm/$

(7Mks)

(c) Using the flow relation $d\theta = \sqrt{M^2 - 1}\ dv$ .show that the Prandtl-Meyer function

$$V(M) = \sqrt{\frac{\gamma+1}{\gamma-1}}\ \arctan\sqrt{\frac{\gamma-1}{\gamma+1}\ (M^2 - 1)}\ - \arctan\sqrt{M^2 - 1}$$ (12Mks)

QUESTION FIVE (20MARKS)

(a) Air flowing in a duct has a velocity of 300m/s, pressure 1.0 bar and temperature 290k.

Taking $\gamma = 1.4$ and $R = 287\ {}^{J}/_{kg}\,k$

Determine

(i) Stagnation temperature and pressure for an isentropic flow (5Mks)
(ii) Velocity of sound in the dynamic land stagnation conditions (4Mks)
(iii) Stagnation pressure assuming constant density (5Mks)

(b) Derive Bernoulli's equation for an isentropic and incompressible flow. (6Mks)