



# TECHNICAL UNIVERSITY OF MOMBASA

FACULTY OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF MECHANICAL & AUTOMOTIVE ENGINEERING

**UNIVERSITY EXAMINATION FOR:**

THE DEGREE IN BACHELOR OF SCIENCE IN MECHANICAL ENGINEERING

EMG 2418 : GAS DYNAMICS AND BOUNDARY LAYER THEORY

END OF SEMESTER EXAMINATION

**SERIES:** APRIL 2016

**TIME:** 2 HOURS

**DATE:** Pick Date May 2016

## Instructions to Candidates

You should have the following for this examination

-Answer Booklet, examination pass and student ID

This paper consists of **FIVE** questions. Attempt any **THREE** questions.

**Do not write on the question paper.**

## Question ONE

- a) Explain briefly the term boundary layer. (4 marks)
- b) Define the following terms
- Boundary layer thickness.
  - Displacement thickness.
  - Energy thickness. (9marks)
- c) The velocity distribution in the boundary layer is given by:

$$\frac{u}{U} = \frac{y}{\delta}$$

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

- The displacement thickness.
- The momentum thickness.

- iii. The energy thickness.
- iv. The value of  $\delta^*/\theta$ .

(8marks)

### Question TWO

- a) Define compressibility. (2marks)
- b) A gas is flowing through a horizontal pipe. On a section where cross-section area is 50cm<sup>2</sup>, the pressure and temperature are found to be 3 bar (gauge) and 20oC respectively. At another section where the area of cross-section is 25cm<sup>2</sup>, the pressure is recorded 2 bar (gauge).if the mass rate of gas through the pipe is 0.6kg/s find the velocities of the gas at these sections assuming an isothermal change. Take R=287J/kg and atmospheric pressure =1 bar. (6marks)
- c) Define the following terms.
  - i. Subsonic flow
  - ii. Sonic flow
  - iii. Supersonic flow
  - iv. Mach Cone(6 marks) mar

### Question THREE

- a) Define the following Terms.
  - i. Drag force
  - ii. Lift force(4marks)
- b) State the factors on which the relative contribution of pressure force and friction drag to the total drag depends. (6 marks)
- c) On a flat plate of 2m (length) x 1m (width), experiments were conducted in a wind tunnel with a wind speed of 50km/h. The plate is kept at such angle that the co-efficient of drag and lift are 0.18 and 0.9 respectively. Determine
  - i. Drag force
  - ii. Lift force
  - iii. Resultant force
  - iv. Power exerted by the air stream on the plate.(take density of air =1.15kg/m<sup>3</sup>) (10 marks)

### Question FOUR

- a) Explain the following terms
  - i. Streamlined bodies
  - ii. Bluff body
  - iii. Terminal velocity

- iv. Stagnation points (8 marks)
- b) Experiments were conducted in a wind tunnel with a wind speed of 50km/h on a flat plate of size 2m long and 1 m wide. The density of air is 1.15kg/m<sup>3</sup>. The coefficient of lift and drag are 0.75 and 0.15 respectively. Calculate
- The lift force
  - The drag force.
  - The resultant force
  - Direction of resultant force.
  - Power exerted by the air on the plate. (12 marks)

#### Question FIVE

- a) Define Mach number and state its significance in compressible fluid flows. (6 marks)
- b) Find the sonic velocity for the following fluids
- Crude oil of sp gravity 0.8 and bulk modulus 153036N/cm<sup>2</sup>
  - Mercury having a bulk modulus of 2648700N/cm<sup>2</sup> (6marks)
- c) An aeroplane is flying at 11000km/hr through still air having a pressure of 7N/cm<sup>2</sup> and temperature - 5oC. Wind velocity is zero. Calculate
- Mach number
  - Stagnation pressure.
  - Stagnation temperature.
  - Stagnation density.
- Take  $R=287.14\text{J/kg K}$ ,  $k=1.4$  (12 marks)