



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 the following terms
- Turbulent boundary layer
 - Laminar boundary layer (4marks)
- b) Describe fine the following boundary layer
- Displacement thickness
 - Momentum thickness
 - Energy thickness (6 marks)

a) The velocity distribution in the boundary layer is given by:

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

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

- The displacement thickness.
- The momentum the thickness.
- The energy thickness. (10 marks)

Question Two

- a) Define the following Terms.
- Drag force
 - 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
- Drag force
 - Lift force
 - Resultant force
 - Power exerted by the air stream on the plate.

(take density of air =1.15kg/m³)

(10 marks)

Question Three

- a) Explain the following terms
- Streamlined bodies
 - Bluff body
 - Terminal velocity
 - 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/m³. 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 four

- a) State the TWO properties which the velocity of sound depends. (2 marks)
- b) Define the following terms of flow which depend on Mach number:

- i. Subsonic flow
 - ii. Sonic flow
 - iii. Supersonic flow (6 marks)
- c) A gas is flowing through a horizontal pipe which is having area of cross-section as 400cm^2 , where pressure is 40N/cm^2 (gauge) and temperature 150°C . At another section the area of cross section is 20cm^2 and pressure is 30N/cm^2 (gauge). If the mass rate of flow of gas through the pipe is 0.5kg/s , Find the velocities of the gas at these sections, assuming as isothermal change. Take $R=292\text{NM/KG Ok}$ and atmospheric pressure $=10\text{N/cm}^2$ (6marks)
- d) Find the sonic velocity for the following fluids
- i. Crude oil of sp gravity 0.8 and bulk modulus 153036N/cm^2
 - ii. Mercury having a bulk modulus of 2648700N/cm^2 (6marks)

Question five

- a) What is turbulence? (2 marks)
- b) Describe the following types turbulent motions
 - i. Wall turbulence.
 - ii. Free turbulence.
 - iii. Convective turbulence. (4 marks)
- c) What are the characteristics of a turbulent flow? (3 marks)
- d) In a pipe of 360mm diameter having turbulent flow, the centre –line velocity is 7m/s and that at 60 mm from the pipe wall is 6m/s . Calculate the shear friction velocity. (5marks)
- e) Calculate the wall shearing stress in a pipe of diameter 100 which carries water. The velocities at the pipe centre and 30 mm from the pipe centre are 2m/s and 1.5m/s respectively. The flow in the pipe is given as turbulent. (6 marks)