



# TECHNICAL UNIVERSITY OF MOMBASA

FACULTY OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF MECHANICAL & AUTOMOTIVE ENGINEERING

**UNIVERSITY EXAMINATION FOR:**

**BACHELOR OF SCIENCE IN MECHANICAL ENGINEERING**

**EMG 2407 : WIND TUNNEL EXPERIMENTAL TECHNIQUES**

**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 question ONE (Compulsory) and any other TWO questions.

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

## Question ONE

- (a) Give the different classifications of wind tunnels. **(4marks)**
- (b) Discuss the DDS – suite with emphasis on the acquisition phase. **(7 marks)**
- (c) An approximate relation for the velocity profile in the laminar boundary layer subject to zero pressure gradient is

$$\frac{u}{u_m} = a_1\eta + a_2\eta^2$$

- i) Determine the values of the constants  $a_1$  and  $a_2$ .
- ii) Evaluate the constants A and B

- iii) Derive the relations for the development of  $\delta$ ,  $\delta^*$  and  $\theta$  with  $x$  when  $\delta = \left( \frac{2\mu Bx}{\rho u_m A} \right)^{\frac{1}{2}}$

**(15marks)**

- (d) Discuss the shadow graph methods as a flow visualization techniques used in wind tunnels. **(4 marks)**

## Question TWO

Describe an experiment to determine the reduction of drag by inducing turbulence in the boundary layer, providing key equations, experimental results and their analysis. **(20 marks)**

## Question THREE

**(a)** Discuss Mach Number, stating its symbol significance and field of application. **(4 marks)**

**(b)** In order to undertake predictions of the lift and drag force on a scale model of an aircraft during a section of its operational envelope involving sea level flight at  $100\text{ms}^{-1}$  where the speed of sound may be taken as  $340\text{m/s}$ , it is supposed to utilize a cryogenic wind tunnel with nitrogen at 5 atmospheres of pressure and a temperature and a temperature of  $-90^\circ\text{C}$ , conditions at which the nitrogen conditions at which the nitrogen density and viscosity may be taken as  $7.7\text{ kg/m}^3$  and  $1.2 \times 10^{-5}\text{ Ns}$ , respectively. The speed of sound in nitrogen at this temperature is  $295\text{m/s}$ . Determine the wind tunnel flow velocity, the scale of the model to ensure full dynamic similarity and the ratio of forces on the model and the prototype. **(9 marks)**

**(c)** Flow through a heat exchanger tube is to be studied by means of a  $1/10$  scale model. If the heat exchanger normally carries water, determine the ratio of pressure losses between the model and the prototype if;

(i) water is used in the model

(ii) air at normal temperature and pressure is used in the model. **(7 marks)**

## Question FOUR

Describe a laboratory experiment for measuring pressure distributions around a circular cylinder in cross flow, giving procedures experimental results and analysis. **(20marks)**

## Question FIVE

**(a)** Discuss blockage corrections in the wind tunnels. **(10 marks)**

**(b)** Using elaborate an diagram and key equation, describe how to preset and regulate the wind speed in the test section of an open wind tunnel. **(10 marks)**