TECHNICAL UNIVERSITY OF MOMBASA

FACULTY OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF MECHANICAL & AUTOMOTIVE ENGINEERING

UNIVERSITY SPECIAL/SUPPLEMENTARY 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, pocket calculator, 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) Discuss the DDS – suite with emphasis on the analysis phase. **(7 marks)**

(b)Proof which of the following expressions describes better velocity distribution for a laminar boundary layer on a flat plate in the absence of a stream wise pressure gradient. Give the reason for your decision.

$$\frac{u}{u_m}=\frac{3}{2}\left(\frac{y}{\delta}\right)-\frac{1}{2}\left(\frac{y}{\delta}\right) \qquad \frac{u}{u_m}=\frac{3}{2}\left(\frac{y}{\delta}\right)-\frac{1}{2}\left(\frac{y}{\delta}\right)^2$$ **(7 marks)**

(c) Discuss the shadow graph and schlieren methods as flow visualization techniques used in wind tunnels. **(12 marks)**

(d) Explain four uses of wind tunnels. **(4 marks)**

Question TWO

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

Question THREE

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

(b) A 7.2 m high and 15m long spillway discharges 94m^3/s discharge under a head of 2.0 If scale model of this spillway is to be constructed, determine model dimensions, head over spillway model and the model discharge. If model experiences a force of 7500N, determine force on the prototype. **(9 marks)**

(c) A streamlined train is 200m long with a typical cross-section having a perimeter of 9m above the wheels. If the kinematic viscosity of air at the prevailing temperature is 1.5 x 10^{-5} m^2/s and density 1.24 kg/m^3, determine the appropriate surface drag (friction drag) of the train when running at 90 km/h. Make allowance for the fact that boundary layer changes from laminar to turbulent on the train surface. **(7 marks)**

Question FOUR

(a) Discuss similitude and the practical applications of modeling **(8 marks)**

(b) A train is 100m long, 2.8 m wide and 7.5m high. The train travels at 180 km/h through air of density 1.2 kg/m^3 and the kinematic viscosity 1.5 x 10^{-5} m^2s^{-1}. You may assume that the frictional drag of the train is equivalent to the drag of a turbulent boundary layer on one side of a flat plate of length l= 100m and breath b=8.3m. Taking that

$\delta = 0.37\left(\frac{v}{u_m}\right)^{1/5} x^{4/5}$ calculate;

(i) The boundary layer thickness at the rear of the train.

(ii)The frictional drag acting on the train.

(iii)The power required to overcome the frictional drag. **(12 marks)**

Question FIVE

(a) Discuss & illustrate with diagrams laser speckle velocimetry as a flow visualization technique in wind tunnel tests. **(10 marks)**

(b) Explain the principle of working of a thermal anemometer. **(10 marks)**