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

SPECIAL/SUPPLEMENTARY EXAMINATION

SERIES: SEPTEMBER 2018

TIME: 2 HOURS

DATE: Sep 2018

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) Discuss the compressible air field as an optical object and flow visualization techniques that suffice from this approach. **(9 marks)**

(b)Proof which of the following expressions describes better a 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.

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

(9 marks)

c) To study the pressure drop in flow of water through a pipe, a model of scale 1/10 is used. Determine the ratio of pressure drops between model and prototype if water is used in the model. In case of air is used determine the ratio of pressure drops. Take at 20°C, ρ_{air} =1.205kg/m^3, μ_{air} =18.14 x 10^{-6}kg/ms, ρ_{water} =1000kg/m^3, μ_{water} =1.006 x 10^{-3}kg/ms.

(6 marks)

d) Discuss 6 applications of wind tunnels. **(6 marks)**

Question TWO

a) Discuss Euler's number, stating the symbol, significance and the field application **(4 marks)**

b) A 1/50 scale model of a proposed power station tailrace is to be used to predict prototype flow. If the design load rejection bypass flow is 1200ms^{-1}, what water flow rate should be used on the model? **(5 marks)**

c) Discuss and with use of schematic diagrams shadowgraph method as a flow visualization techniques **(11 marks)**

Question THREE

Describe the experiment to determine that drag can be reduced by inducing turbulence in the boundary layer, giving key equations, schematic representation, experimental results and their explanation. **(20 marks)**

Question FOUR

a) 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 developments of $\delta, \delta^* and \theta$ with *x.* **(14 marks)**

b) The total drag on a ship having a wetted hull area of 2500m^2 is to be estimated. The ship is to travel at a speed of 12m/s. A model 1/40 scale when tested at corresponding speed gave a total resistance of 32N. From other tests the frictional resistance to the model was found to follow the law F_{sm}= 3.7 $u^{1.95}$ N/m^2 of wetted area. For the prototype the law is estimated as follows F_{sp} =2.9 $u^{1.8}$N/m^2 of wetted area. Determine the expected total resistance. **(6 marks)**

Question FIVE

a) Discuss the DDS – Suite system with emphasis on the acquisition phase. **(7 marks)**

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

c) Explain different types of similitude that exist in modeling engineering structures. **(3 marks)**