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University Examinations 2012/2013

SECOND YEAR, FIRST SEMESTER EXAMINATION FOR THE DEGREE OF MASTER OF SCIENCE IN APPLIED MATHEMATICS

SMA 3135: FLUID MECHANICS II

DATE: AUGUST 2013 **TIME: 3 HOURS**

INSTRUCTIONS: *Answer question **one** and any other **two** questions*

QUESTION ONE – (30 MARKS)

(a) Distinguish between the following
  (i) Longitudinal and transverse waves. (2 Marks)
  (ii) Subcritical and supercritical fluid flows. (2 Marks)

(b) Define each of the following terms as used in fluid mechanics
  (i) Open channel flow (1 Mark)
  (ii) Thermal boundary layer (2 marks)

(c) Give the significance of the prandtl number as used in fluid mechanics. (3 Marks)

(d) A geometrically similar model of an air ship was tested in deep water. The length of the model was 10m and a pressure drop of $250KNm^{-2}$ is experienced. Find the corresponding pressure drop in the full scale prototype of length 360m given that water is 50 times more viscous and 800 times denser than air. (6 Marks)

(e) Water runs on a semicircular channel of radius 1m on a slope of 1 in 100. Given that $n = 0.012$, Calculate the uniform flow rate occurring at a depth of 75cm. (7 Marks)

(f) Show that the equation of potential in the theory of sound is given by:
$\frac{\partial^2 \emptyset}{\partial t^2} = c^2 \nabla^2 \emptyset$ (7 Marks)

QUESTION TWO – (20 MARKS)

(a) State any two modes of heat transfer. (2 Marks)

(b) A trapezoidal open channel with uniform flow has a normal depth of $4m$. The channel base width is $6m$, the side slopes are $1:2$, the bed slope is $1\ in\ 10{,}000, n = 0.0145 \quad \rho = 1000kg/m^3, \mu = 1.14 \times 10^{-3}$ Pas. Calculate:

(i) The discharge. (3 Marks)

(ii) The mean velocity (2 Marks)

(iii) The Reynold's number (3 Marks)

(c) Derive an equation for the velocity of a steady, incompressible couette flow for two infinite parallel plates located at the planes $y = 0\ and\ y = b$. (10 Marks)

QUESTION THREE – (20 MARKS)

(a) Show that the pressure coefficient $C_P = \frac{P}{\rho u^2}$ is dimensionless. (4 Marks)

(b) The velocity distribution in the laminar boundary layer of a flat plate is given by $\frac{u}{U} = 6\frac{y}{\delta} - 2\left(\frac{y}{\delta}\right)^2$ Calculate,

(i) The shape factor (6 Marks)

(ii) The energy loss due to boundary layer at a particular section where the boundary layer thickness is 20mm and the free stream velocity is 10m/s. (take $\rho = 1200kg/m^3$) (6 Marks)

(c) Calculate the rate of flow through a rectangular channel of width 7m with a slope of $1\ in\ 10{,}000$ for a depth of flow of $1.2m$ where $n = 0.015$. (4 Marks)

QUESTION FOUR – (20 MARKS)

(a) Derive the differential form of one dimensional wave equation for a progressive wave along the x axis. (6 Marks)

(b) Formulate the 2 dimensional prandt'l boundary layer equations for a steady incompressible flow over a flat plate placed along the x axis. (11 Marks)

(c) State the three distinct regions in the turbulent boundary layer. (3 Marks)