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University Examinations 2012/2013

FIRST YEAR, THIRD SEMESTER EXAMINATION FOR MASTER OF SCIENCE IN APPLIED MATHEMATICS

SMA 3135: FLUID MECHANICS II

DATE: DECEMBER 2012 **TIME: 3HOURS**

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

QUESTION ONE - (30 MARKS)

a) Differentiate between kinematic and dynamic similarity. (3 Marks)

b) Define the hydraulic mean depth (D_m) as used in relation to open channels. (3 Marks)

c) A 4m wide rectangular channel has a slope of 1 in 10,000. Given that the depth of flow is 1.6m and n=0.015 compute the rate of flow. (5 Marks)

d) Calculate the momentum thickness of a fluid flow whose velocity distribution in the Laminar boundary layer of a flat plate is

$$\frac{u}{U} = \frac{5}{3}\frac{y}{\delta} - \frac{4}{3}\left(\frac{y}{\delta}\right)^2$$ (5 Marks)

e) Describe each of the modes of heat transfer in fluids. (6 Marks)

f) What is the difference between deep water and shallow water waves? (3 Marks)

g) State any on non dimensional number and describe the parameters governing the number with reference to flow of fluids. (5 Marks)

QUESTION TWO – (20 MARKS)

a) A trapezoidal channel has equal side slopes of $1:\sqrt{3}$. The bed slope is 1 in 10,000 and n = 0.016. Given that the channel's base width is 6m and normal depth is 3m compute

i. The discharge (5 Marks)

ii. Mean velocity (2 Marks)

iii. The Reynold's number (4 Marks)

b) Show that a hydraulically efficient circular channel is one whose depth of flow is $y = 1.88\, r \; and \; \theta \cong 151°$ where r is the radius of the circle and θ is the angle subtending the surface of the fluid at the centre. (9 Marks)

QUESTION THREE – (20 MARKS)

c) Define the following terms as used in fluid mechanics.
   i. No slip condition (2 Marks)
   ii. Boundary layer (2 Marks)
   iii. Dimensional analysis (2 Marks)

d) The velocity distribution of a fluid flow in the laminar boundary layer of a flat plate is given by $\frac{u}{U} = 2\left(\frac{y}{\delta}\right)^3 - 3\left(\frac{y}{\delta}\right)^2 + \left(\frac{y}{\delta}\right)$

   Compute the values of each of the following
   i. Displacement thickness (4 Marks)
   ii. Momentum thickness (4 Marks)
   iii. Energy thickness (4 Marks)
   iv. Shape factor (2 Marks)

QUESTION FOUR – (20 MARKS)

Couette flow is defined such that two infinite parallel plates confine the flow such that the upper plate moves with velocity U and lower plate is stationary. If the upper plate is located along y=b derive expression for:

a) Velocity profiles. (10 Marks)
b) Discharge per unit width of plate. (5 Marks)
c) Skin friction (5 Marks)