MERU UNIVERSITY OF SCIENCE AND TECHNOLOGY

P.O. Box 972-60200 – Meru-Kenya.
Tel: +254(0) 799 529 958, +254(0) 799 529 959, +254 (0)712 524 293
Website: www.must.ac.ke Email: info@mucst.ac.ke

UNIVERSITY EXAMINATIONS 2023/2024

FIRST YEAR SECOND SEMESTER EXAMINATION FOR DEGREE OF MASTERS OF SCIENCE IN APPLIED MATHEMATICS

SMA 5135: FLUID MECHANICS IV

DATE: APRIL 2023 **TIME: 2 HOURS**

INSTRUCTIONS: Answer Question ONE and any other TWO questions.

QUESTION ONE (30 MARKS)

a) Distinguish between the following

i. Longitudinal and transverse waves (2marks)

ii. Subcritical and supercritical fluid flows (2marks

b) Define each of the following as use in flued mechanics

i. Open channel flow (1mark)

ii. Thermal boundary layer (2marks)

c) Given the significance of the prandh numbers used in fluid mechanics (3marks)

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 (6marks)

e) Water runs on 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 (7marks)

f) Show that the equation of potential in the theory of sound is given by $\frac{\partial^2 \phi}{\partial t^2} = C^2 \nabla^2 \phi$ (7marks)

QUESTION TWO (15 MARKS)

a) State any two modes of heat transfer (2marks)

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 10,000m n=0.0145,

ρ =1000kg/m^3,$\mu = 1.14x10^{-3}$ pas

c) Calculate

i. The discharge (3marks)

ii. The mean velocity (2marks)

iii. The Reynolds number (3marks)

d) Show that the pressure coefficient $c_p = \frac{p}{\rho u^2}$ is dimensionless (5marks)

QUESTION THREE (15 MARKS)

a) 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 (5marks)

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 ρ =1200kg/m^3) (6marks)

b) 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 (4marks)

QUESTION FOUR (15 MARKS)

a) State the three distinct regions in the turbulent boundary layer (3marks)

b) Formulate the 2 dimensional prandt'l boundary layer equations for a steady incompressible flow over a flat plate placed along the x axis (12marks)

QUESTION FIVE (15 MARKS)

a) Derive the differential term of one dimensional wave equation for a progressive wave along the x axis (6marks)

b) Derive an equation for the velocity of a steady incompressible couette flow for two infinite parallel plates located at the planes $y = 0$ and $y = b$ (9marks)