(*University of Choice*)

MASINDE MULIRO UNIVERSITY OF SCIENCE AND TECHNOLOGY (MMUST)

MAIN CAMPUS

UNIVERSITY EXAMINATIONS 2020/2021 ACADEMIC YEAR

SECOND YEAR FIRST SEMESTER EXAMINATIONS

FOR THE DEGREE OF BACHELOR OF SCIENCE IN CIVIL AND STRUCTURAL ENGINEERING AND BACHELOR OF TECHNOLOGY IN BUILDING CONSTRUCTION

COURSE CODE: CSE 251

COURSE TITLE: FLUID MECHANICS I

DATE: FRIDAY 12TH FEBRUARY 2021 TIME: 9.00 – 11.00 AM

Instructions to candidates

- This paper consists of **FIVE** questions.
- Answer question **ONE** and **ANY** other **THREE** questions
- All symbols have their usual meaning unless otherwise stated
- Time allowed is **TWO (2)** hours

MMUST observes ZERO tolerance to examination cheating

This Paper Consists of 4 Printed Pages. Please Turn Over.

Question ONE {Compulsory (25 marks)}

a) Explain the following forms of equilibrium (3 marks)
   i. Stable equilibrium.
   ii. Unstable equilibrium
   iii. Neutral equilibrium

b) Define and give the units of the following terms used in fluid mechanics (4 marks)
   i. Specific weight
   ii. Specific gravity
   iii. Specific volume
   iv. Kinematic viscosity

c) A uniform body of size 3m long by 2m wide and 1m deep floats in water, Figure 1(c). Determine:
   i. The weight of the body if the depth of immersion is 0.8m (1 mark)
   ii. The meta-centric height (3 marks)

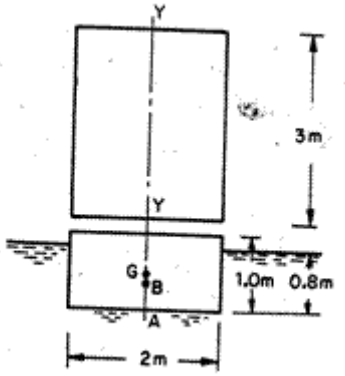

Figure 1(c)

d) Find out the differential reading *'h'* of an inverted U-tube manometer containing oil of specific gravity of 0.7 as manometric fluid when connected across pipes A and B as show in Figure 1(d) below, conveying liquids of specific gravities 1.2 and 1.0 pipes A and B are located at the same level and assume the pressures at A and B to be equal (6 marks)

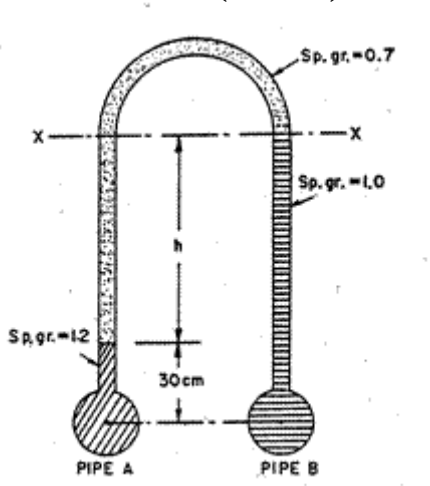

Figure 1(d)

e) State Pascal's law for pressure at a point and using arbitrary small wedge shaped fluid element, proof the law (8 marks)

Question TWO (15 marks)

a) Explain the following types of fluids based on viscosity (4 marks)
   i. Ideal fluid (or perfect fluid)
   ii. Newtonian fluids-
   iii. Ideal plastic fluid (Bingham plastic)
   iv. Plastic

b) A sluice gate is in the form of a circular arc of radius 6m as shown in Figure 2(b) below. Determine the magnitude and direction of the resultant force on the gate (11 marks)

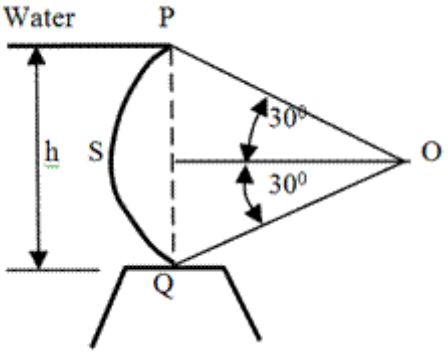

Figure 2(b)

Question THREE (15 marks)

a) Differentiate the following flow patterns (3 marks)
   i. Steady and unsteady flow
   ii. Uniform and non-uniform flow
   iii. Laminar and turbulent flow

b) The velocity vector is given by $V=4x^3_i -10x^2_j +2t_k$. Determine the velocity and acceleration of a fluid particle at (2, 1, 3) at time t = 1 (12 marks)

Question FOUR (15 marks)

a) State the hydrostatic law (2 marks)

b) The velocity distribution over a plate is given by: $u = \frac{2}{3}y - y^2$ in which u is the velocity in m/s at a distance of y metres above the plate. Determine the shear stress at y = 0 and y = 0.15m. Take dynamic viscosity of the fluid μ as 0.863 Ns/m^2 (5 marks)

c) A 7.2m high and 15m long spillway discharges 94m^3/s under a head of 2m. If a 1:9 model of this spillway is to be constructed, determine:
   i. The model dimensions (2 marks)
   ii. The head over spillway model (2 marks)
   iii. The model discharge (2 marks)
   iv. The force on the prototype if model experiences a force of 7.5kN (2 marks)

Question FIVE (15 marks)

a) What is 'buoyancy'? State Archimedes' principle (3 marks)

b) Prove that the discharge over a spillway is given by:-

$$Q = VD^2[\frac{\sqrt{gD}}{V}, \frac{H}{D}]$$

Where V is the velocity of flow, D is depth of the throat, H is head of water and g is acceleration due to gravity (12 marks)