MACHAKOS UNIVERSITY

University Examinations 2016/2017

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF MECHANICAL AND MANUFACTURING ENGINEERING

SECOND YEAR SECOND SEMESTER EXAMINATION FOR BACHELOR OF SCIENCE IN ELECTRICAL AND ELECTRONICS ENGINEERING SUPPLIMENTARY EXAMINATION

EEE 209 FLUID MECHANICS

DATE: 1/9/2017 **TIME: 2:00 – 4:00 PM**

INSTRUCTIONS

Answer Question one and any other Two questions.

QUESTION ONE (COMPULSORY) (30 MARKS)

a) State the Pascal's Law for Pressure at a Point (2 marks)

b) Consider a plane surface, immersed in a liquid whose free surface is indicated as OO as shown in **Figure Question 1(a)** Show that the total pressure, P on the surface can be given by, $P = \rho g A\bar{x}$ or total pressure on a surface is equal to the area multiplied by the intensity of pressure at the centre of area of the figure

Where: ρ = density of the liquid

g = force of gravity

A = area of surface

$\bar{x}$ = depth of centre of gravity of inclined area from free surface (6 marks)

c) A block of wood 4m long × 2m wide ×1m deep is floating horizontally in water. If the density of wood is 700 kg/m^3, determine the volume of water displaced and the position of centre of buoyancy. (5 marks)

d) Explain how metacetric height of a floating vessel may be determined experimentally (8 marks)

e) Differentiate between laminar and turbulent fluid flow (2 marks)

f) Water flows through a horizontal venturimeter with diameters of 0.6m and 0.2m. The gauge pressure at the entry is 1 bar. Determine the flow rate when the throat pressure is 0.5 bar (vacuum). Barometric pressure is 1 bar. Use Bernoulli's equation. (7 marks)

QUESTION TWO (20 MARKS)

a) Determine the magnitude and direction of the resultant water pressure acting on a curved face of a dam which is shaped according to the relation, $y = x^3/8$ as shown in **Figure Question 2(a)** Take the width of dam as unit (10 marks)

b) A cylinder 400mm long, 90mm in diameter has its base 15mm thick and of specific gravity 6. The remaining part is of specific gravity 0.4. Determine if it can float vertically in water (10 marks)

QUESTION THREE (20 MARKS)

a) Check whether the following velocity relations satisfy the requirements for steady irrotational flow.

$(i)\ u = x + y,\ v = x - y \qquad (ii)\ u = xt^2 + 2y\ ,\ v = x^2 - y\ t^2 \qquad (iii)\ u = xt^2,\ v = xyt + y^2$

(6 marks)

b) State **three** assumptions involved in Euler's equation of motion as applied in fluid flow (3 marks)

c) A liquid of specific gravity 1.3 flows in a pipe at a rate of 800 litres per second, from point 1 to point 2 which is 1 m above point 1. The diameters at section 1 and 2 are 0.6m and 0.3m respectively. If the pressure at section 1 is 10 bar, determine the pressure at section 2 (5 marks)

d) A siphon is shown in **Figure Question 3(d)**. Point A is 1m above the water level, indicated by point 1. The bottom of the siphon is 8m below level A. Assuming friction to be negligible, determine the speed of the jet at outlet and also the pressure at A (6 marks)

QUESTION FOUR (20 MARKS)

a) Water is discharged through a 15cm diameter orifice in the vertical side of an open tank at the rate of 190 litres per second. Water stands 15m above the centerline of the orifice. A point on the jet measured from the vena contracta has co-ordinates 5m horizontal and 0.5m vertical. Find the hydraulic coefficient of velocity, coefficient of contraction and coefficient of discharge of the orifice (10 marks)

b) i Derive an expression for the flow measurement in an open channel using rectangular notch and show that the total discharge, Q can be given by,

$$Q = \frac{2}{3} C_d B \sqrt{2g} H^{3/2}$$

Where, C_d is the coefficient of discharge

g is force of gravity

Consider **Figure Question 4(b).** (5 marks)

ii A rectangular notch is used to measure the flow rate of water in an open channel. The width of the rectangular notch is 3m and the head of water causing the flow is 0.5m. Calculate the discharge assuming the coefficient of discharge of the notch as 0.6 (2 marks)

iii What should be the width of a rectangular notch that should be used to measure the water flow rate of $0.5m^3/s$ in an open channel. The head causing the flow should not exceed half the notch width. Assume the coefficient of discharge of the rectangular notch as 0.6 (3 marks)

QUESTION FIVE (20 MARKS)

a) Describe the following hydrodynamic machinery with the aid of sketches (i) axial flow pump (ii) centrifugal pump (iii) impulse turbine (9 marks)

b) What power in kilowatts can be developed by the impulse turbine shown in **Figure Question 5(b)** if the turbine efficiency is 85%? Assume that the resistance coefficient of the penstock is 0.015 and the head loss in the nozzle itself is negligible. What will be the angular speed of the wheel, assuming ideal conditions and what torque will be exerted on the turbine shaft? (11 marks)

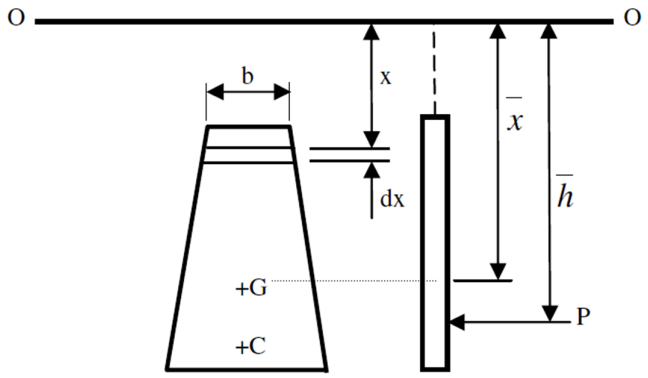

Figure Question 1(a)

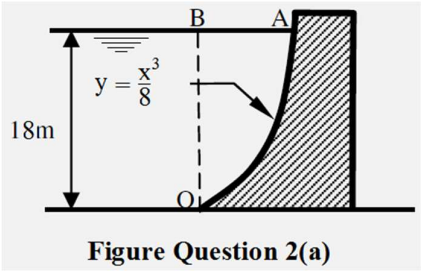

Figure Question 2(a)

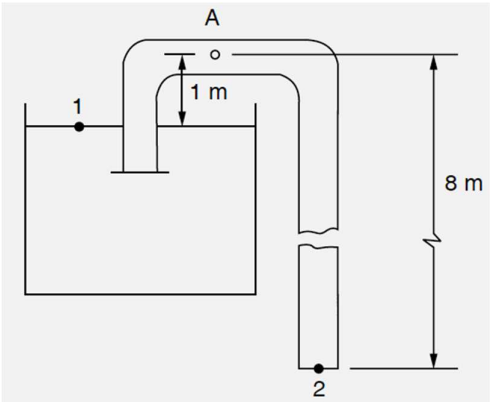

Figure Question 3(d)

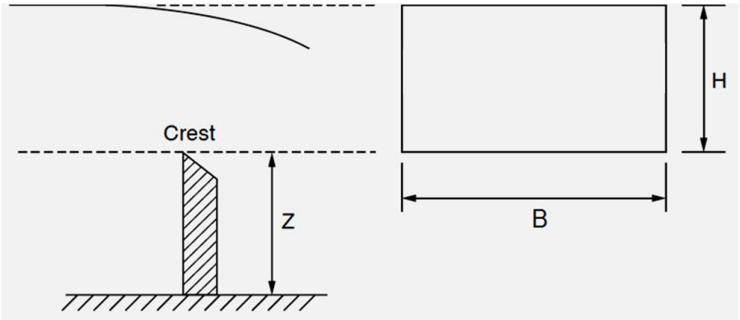

Figure Question 4(b).

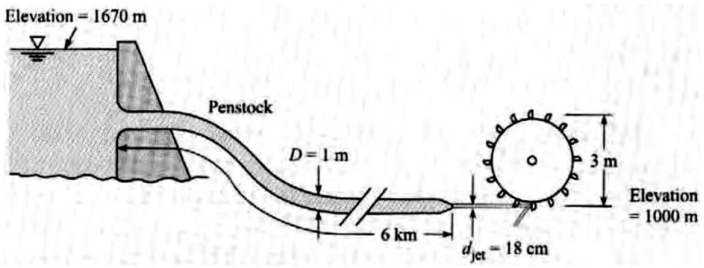

Figure Question 5(b)