



MACHAKOS UNIVERSITY

University Examinations 2018/2019

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF MECHANICAL AND MANUFACTURING ENGINEERING

SECOND YEAR SPECIAL/SUPPLEMENTARY EXAMINATION FOR

BACHELOR OF SCIENCE IN MECHANICAL ENGINEERING

EMM 204: FLUID MECHANICS 1

DATE: 27/9/2019

TIME: 8.30-10.30 AM

INSTRUCTIONS:

This paper contains FIVE questions

Question ONE is **compulsory** and carries 30 Marks

Questions TWO – FIVE carries 20 Marks each. **Answer any Two**

QUESTIONS ONE (30 MARKS)

- a) Come up with the expression for rate of flow through a venturimeter (6 Marks)
- b) Discuss the effects of temperature on the viscosity of liquids and gases (4 Marks)
- c) Prove that the intensity of pressure at a point in a fluid at rest is the same in all directions (6 Marks)
- d) State the Newton's law of viscosity and hence differentiate between Newtonian and Non-Newtonian fluids (2 Marks)
- a) A rectangular plate 3 meters long and 1 meter wide is immersed vertically in water such a way that its 3 meters side is parallel to the water surface and is 1 meter below it.
 - i. Total pressure on the plate (3 Marks)
 - ii. Position of center of pressure (3 Marks)
- e) Briefly define surface tension (2 Marks)
- f) Name the three parts of a venturimeter (3 Marks)
- g) What is an orifice (1 Marks)

QUESTIONS TWO (20 MARKS)

- a) Define a fluid and differentiate between liquids and gases (3Marks)
- b) Calculate the capillary rise in a glass tube of 2.5mm diameter when immersed vertically in (a) water (b) mercury. Take surface tension $\sigma = 0.0725 \text{ N/m}$ for water and $\sigma = 0.52 \text{ N/m}$ for mercury in contact with air. The specific gravity for mercury is given as 13.6 and angle of contact = 130° (3 Marks)
- c) A circular opening 2.5m diameter, in a vertical side of a tank is closed by a disc of 2.5m diameter which can rotate about a horizontal diameter. Determine:
- The force on the disc (3 Marks)
 - The torque required to maintain the disc in equilibrium in vertical position when the water head above the horizontal diameter is 3.5m.
- (Use $I_{CG} = \frac{\pi d^4}{64}$) (5 Marks)
- d) A solid cylinder of diameter 4.0m has a height of 4m. Find the metacentric height of the cylinder if the specific gravity of the cylinder material is 0.6 and it is floating in water with its axis vertical. State whether the equilibrium is stable or unstable.

(6 Marks)

QUESTIONS THREE (20 MARKS)

- a) i. What is meant by the terms; absolute pressure and gauge pressure (4 Marks)
- ii. Determine the gauge and absolute pressure at a point which is 2m below the free water surface. Take the atmospheric pressure as 760 mm of mercury (3 Marks)
- b) i. Define the terms; notch, weir, nappe and crest (4 Marks)
- ii. Derive an expression of discharge through a triangular weir (5 Marks)
- h) The velocity distribution for flow over a flat plate is given by $u = \frac{3}{2}y - y^{\frac{3}{2}}$ in which 'u' is the velocity in m/s at a distance 'y' meters above the plate. Calculate the shear stress at $y = 9 \text{ cm}$.

(Take dynamic viscosity of fluid as 0.8 Ns/m^2) (4 Marks)

QUESTIONS FOUR (20 MARKS)

- i) Differentiate between the following:
- Liquids and gases (2 Marks)
 - Relative density and specific weight (2 Marks)

- iii. Centre of gravity and centre of pressure (2 Marks)
- a) Water flows through a pipe having diameters of 30cm and 20cm respectively. The intensity of pressure at the bottom end is $24.525 \times 10^4 \text{ N/m}^2$ and the upper end is $9.81 \times 10^4 \text{ N/m}^2$. Determine the differences in datum head if the discharge through the pipe is 40l/sec (4 Marks)
- b) A pipe contains oil of specific gravity 0.8. A differential manometer connected at the two points “A” and “B” of the pipe shows a difference in mercury level of 20cm. Find the difference in pressure in N/m^2 (5 Marks)
- c) The dynamic viscosity of oil used for lubrication between shaft and sleeve is 0.6 Ns/m^2 . The shaft is of diameter 0.4m and rotates at 190 rpm. Calculate the shaft torque and the horse power lost in the bearing for a sleeve length of 90mm. The thickness of the oil film is 1.5mm. (Take 1 horsepower = 736 watts). (5 Marks)

QUESTION FIVE (20 MARKS)

- a) Describe the difference between laminar flow and turbulent flow (4 Marks)
- b) Calculate the Reynolds number for a fluid of density 900 kg/m^3 and dynamic viscosity $1 \times 10^{-3} \text{ kg/m.s}$ flowing in a 4 mm diameter pipe at 3m/s. Determine whether the flow is laminar or turbulent. (4 Marks)
- c) Water flows through a pipe of diameter 5 cm under a pressure of 29.43 N/cm^2 (gauge) and with mean velocity of 2 m/s. Find the total head at a cross-section which is 5m above the datum line. (3 Marks)
- d) A pipe through which water flows has a diameter of 20cm and 10cm at cross-section 1 and 2 respectively. The water velocity at section 1 is 4m/s. Find the velocity head at section 1 and 2 and also the discharge (Q) through the pipe (5 Marks)
- e) A hydraulic press has a ram of 30cm diameter and a plunger of 45cm diameter. Find the weight lifted by the hydraulic press when the force applied at the plunger is 500 N (4 Marks)