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KIBABII UNIVERSITY
UNIVERSITY EXAMINATIONS
2017/2018 ACADEMIC YEAR

SECOND YEAR FIRST SEMESTER

MAIN EXAMINATIONS

FOR THE BACHELOR OF RENEWABLE ENERGY AND BIOFUELS TECHNOLOGY

COURSE CODE : PRD 232

COURSE TITLE : FLUID MECHANICS I

DURATION : 2 HOURS

DATE : 17TH JANUARY 2018

TIME : 9 – 11 AM

INSTRUCTIONS TO CANDIDATES

- Answer QUESTION ONE (Compulsory) and any other TWO (2) Questions.
- Indicate **answered questions** on the front cover.
- Start every question on a new page and make sure question's number is written on each page.
- Take $g = 9.81\text{m/s}^2$, density of water = 1000kg/m^3 , density of air = 1.18kg/m^3

QUESTION ONE (30 MARKS)

- a) i) Differentiate between specific weight and specific gravity of a fluid (2 marks)
- ii) Show that the capillary rise, h in a glass tube containing a liquid that wets the glass is given by :

$$h = \frac{4\sigma \cos\theta}{\rho g d} \quad (4 \text{ marks})$$

- b) Calculate the capillary effect in millimeters in a glass tube of 4mm diameter, when immersed in water (Take surface tension for water as 0.0735N/m ; The contact angle of water, $\theta = 0^\circ$) (3 marks)
- c) Briefly explain the continuum concept of a fluid and how it relates to liquids (2 ½ marks)
- d) A simple manometer is used to measure the pressure of a certain oil of specific gravity 0.8 flowing in a pipeline as shown in figure 1 below:

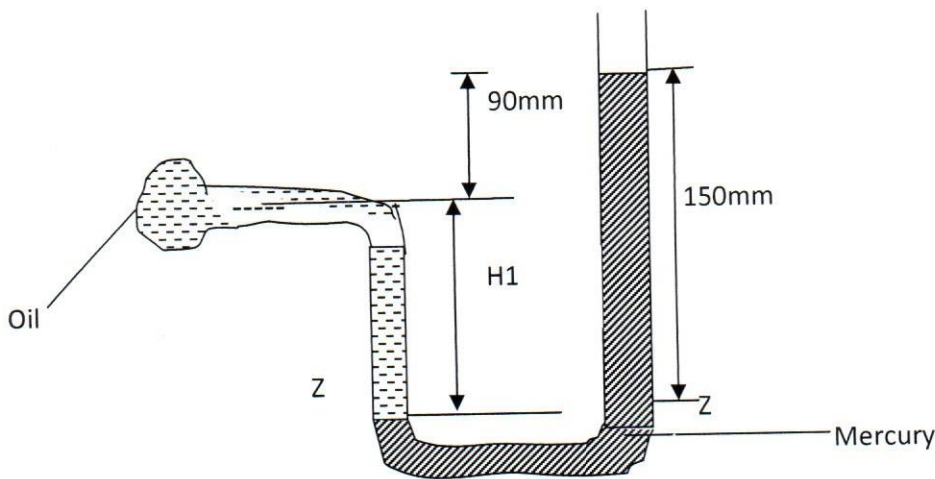


Figure 1

If the specific gravity of Mercury is 13.6, find the pressure of oil in the pipe. (5 marks)

- e) With the aid of a suitable sketch, explain the operation principle of a Bourdon gauge in the measurement of fluid pressure (4 ½ marks)
- f) i) What is the centre of pressure with respect to a plane surface immersed in a liquid? (2 marks)

- ii) Derive an expression for determining the total thrust on a vertical plane surface immersed in a liquid (7 marks)

QUESTION TWO (20 MARKS)

- a) Define the following terms in relation to fluid flow:
- i. Streamline
 - ii. Stream tube
 - iii. Compressible flow
 - iv. Incompressible flow (6 marks)
- b) i. Calculate the Reynold's number for a fluid of density 900kg/m^3 and viscosity 0.038 poise flowing in a 50mm diameter pipe at the rate of 2.5 litres/sec (5 marks)
- ii. Calculate the critical mean velocity if the pipe in (i) above is straight, uniform and of moderate size (2 marks)
- c) i. State Bernoulli's Theorem (1 mark)
- ii. State FOUR limitations of Bernoulli's equation (2 marks)
- d) With the aid of suitable sketches, briefly describe the boundary layer concept with respect to fluid flow in a pipe (3 marks)

QUESTION THREE (20 MARKS)

- a) State any THREE assumptions made in the derivation of Euler's equation for steady flow of an ideal liquid along a streamline (3 marks)
- b) Oil flows along a horizontal pipe which varies uniformly in section from 100mm diameter at A to 150mm diameter at B. At A, the gauge pressure is 126KN/m^2 and at B 140KN/m^2 . Find the flow rate in Litres per second and in kilograms per second. The density of the oil is 0.8g/cm^3 (17 marks)

QUESTION FOUR (20 MARKS)

a) i. What is a stagnation point? (2 marks)

ii. Give a clear description how the principle of the stagnation point is applied in the operation of a pitot tube (8 marks)

b) Explain the following terms related to fluid flow around submerged bodies:

i. Lift

ii. Drag

(3 marks)

c) A flat plate 2m x 3m is immersed in water flowing with a velocity of 5m/s. Find the force of drag on the plate. Take $K_D = 0.05$ (3 marks)

d) Name and describe the two types of resistance likely to occur in pipe flow (4 marks)

QUESTION FIVE (20 MARKS)

a) State the function of a diffuser in pipe fittings (2 marks)

b) Show that the loss of head when a pipe undergoes a sudden contraction is given by:

$$h_L = \frac{KV^2}{2g}$$

(13 marks)

c) A pipe of section 0.1m^2 suddenly changes to 0.3m^2 area. The quantity of water flowing in the pipe is 0.2m^3 . Find the head loss due to the sudden enlargement (5 marks)