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FEDERAL UNIVERSITY OYE-EKITI
DEPARTMENT OF MECHANICAL ENGINEERING
B.Eng. Degree Examination
Second Semester 2016/2017 Session
COURSE CODE: MEE206
COURSE TITLE: FLUID MECHANICS I UNITS: 2
TIME ALLOWED: 2½Hours
INSTRUCTION: Answer ANY FOUR questions.

Question One

(a) For both isothermal and isentropic processes prove that $K = P$. Where K is bulk modulus.
(b) A cylinder contains 0.96 m^3 of air at 60°C and 1.9 bar. The air is compressed to 0.096 m^3
(i) Assuming isothermal conditions, what is the pressure at the new volume and what is the bulk modulus of elasticity.
(ii) Assuming isentropic conditions, what is the final pressure and temperature and what is the bulk modulus of elasticity. Given that $\gamma = 1.4$
(iii) Find the density of oil whose relative density is 0.75

Question Two

(a) Using the diagram below labelled Figure Q2, find the relationship between P_A –P_B

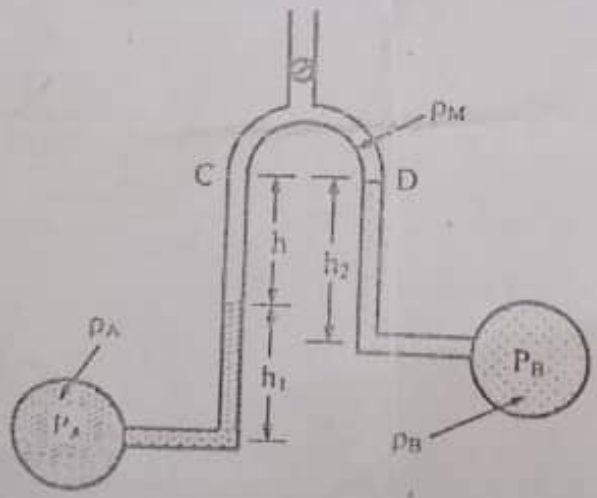

Figure Q2

(b) An Inverted U-tube as shown in Figure Q2 above is used to measure the pressure difference between two points A and
B. Fluid A is water and the top of the manometer is filled with oil of relative density 0.75. If h_1 is 0.25 m, h_2 is 0.3 m and h is 0.2 m, calculate the pressure difference
(i) when fluid B is liquid of relative density 0.8
(ii) When fluid B is water
(iii) What will be the pressure difference in (a) and (b) when the top of the manometer is filled with air instead of oil.

Question Three

(a) Differentiate between *steady non-uniform flow* and *unsteady uniform flow*. Give an example of each type of flow.

(b) Determine whether the following expressions satisfy the continuity equation;

(i) $u = 10xt$, $v = -10yt$, $\rho = constant$

(ii) $u = U(\frac{x}{s})^{\frac{1}{7}}$, $v = 0$, $\rho = constant$

(c) Water flows through a pipe AB 1.2 m in diameter at 3 m/s and then passes through a pipe BC which is 1.5 m in diameter. At C the pipe forks. Branch CD is 0.8 m in diameter and carries one-third of the flow in AB. The velocity in branch CE is 2.5 m/s.

Find:

(i) the volume rate of flow in AB

(ii) the velocity in BC

(iii) the velocity in CD

(iv) the diameter of CE

Question Four

(a) Given the following equation for incompressible flow (i.e constant density)

$$p_1 + \frac{1}{2}\rho v_1^2 + \rho g z_1 + \rho q - \rho w = p_2 + \frac{1}{2}\rho v_2^2 + \rho g z_2 + \rho \Delta_e$$

All symbols have their usual meanings.

(i) Identify the above equation

(ii) What do the terms represent and what are their units or dimensions?

(b) A flat plate is struck normally by a jet of water 50 mm in diameter with a velocity of 18 m/s. Calculate:

(i) the force on the plate when it is stationary

(ii) the force on the plate when it moves in the same direction as the jet with a velocity of 6m/s

(c) the work done per second and the efficiency in case (b)

Question Five

The diameter of a pipe suddenly increases from 300 mm to 550 mm. One leg of a mercury U- tube is connected just upstream of the change while the other leg is connected to the larger section at short distance downstream of the change. There is a difference of 25 mm in the mercury levels, and the rest of the gauge is filled with water. Determine:

(i) the flow velocities in the two sections

(ii) the discharge

The relative density of mercury is 13.6 and acceleration due to gravity, g = 9.81 m/s^2.

Question Six

(a) Briefly explain the following:

(i) Uniform flow

(ii) Non-uniform flow

(iii) Laminar flow

MTE/2018/1249

FEDERAL UNIVERSITY OYE-EKITI
FACULTY OF ENGINEERING
DEPARTMENT OF MECHANICAL ENGINEERING
2019/20 FIRST SEMESTER EXAMINATION

COURSE TITLE: Fluid Mechanics I
CODE: MEE206
TIME ALLOWED: 2 Hours
UNITS: 2.0
CLASS: All Level Two Engineering and WMA
INSTRUCTIONS: Attempt any four questions

QUESTION ONE

a) i) Explain Pascal law, ii) define isothermal and isentropic process
b) With the aid of a diagram explain the principle of Inverted U-Tube manometer.
c) A U-tube manometer is arranged as shown in Figure 1, to measure the pressure difference between two pipelines A and B, both carrying water of density 1000 kg/m^3. The density of manometric fluid is 13,600 kgm^{-3}. Calculate the pressure difference if h_1 is 2.2 m, h_2 is 1.1 m and h is 1.0 m.

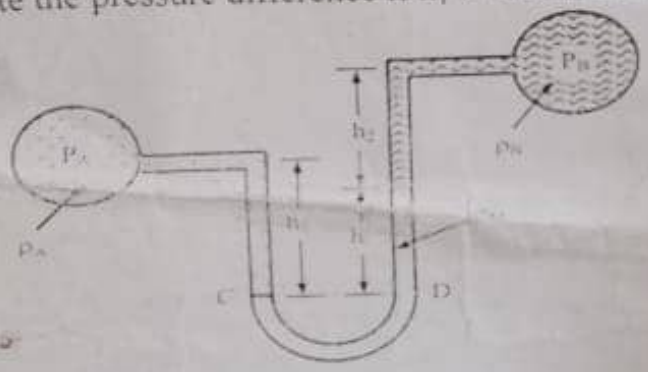

Figure1

QUESTION TWO

a) With the aid of a diagram explain metacenter and metacentric height as it relates to
b) Define the following terms
   i. Viscosity ii) Kinetic viscosity iii) Surface tension
c) Draw the diagram of variation of shear stress with gradient of different types of fluid and the relationship between shear (τ), and rate of angular deformation for various types of fluid.
d) With the aid of diagram explain the capillary phenomenon. Hence show that $h = \frac{4\sigma\cos\theta}{\rho g d}$

QUESTION THREE

a) A trapezoidal 2m wide at the bottom and 1m deep has side slopes 1:1. Determine:
   i) Total pressure
   ii) Centre of pressure on the vertical gate closing the channel when it is full of water.
b) Derive the Continuity Equation
c) Define rate of flow (discharge)

QUESTION FOUR

a) Define Absolute, gauges and atmospheric pressures

b) A pipe (1) 450 mm in diameter branches into two pipes (2) and (3) of diameters 300 mm and 200 mm respectively as shown in Figure 2. If the average velocity in 450 mm diameter pipe is 3 m/s find;

i) Discharge through 450 mm diameter pipe

ii) Velocity in 200 mm diameter pipe if the average velocity in 300 mm pipe is 2.5 m/s.

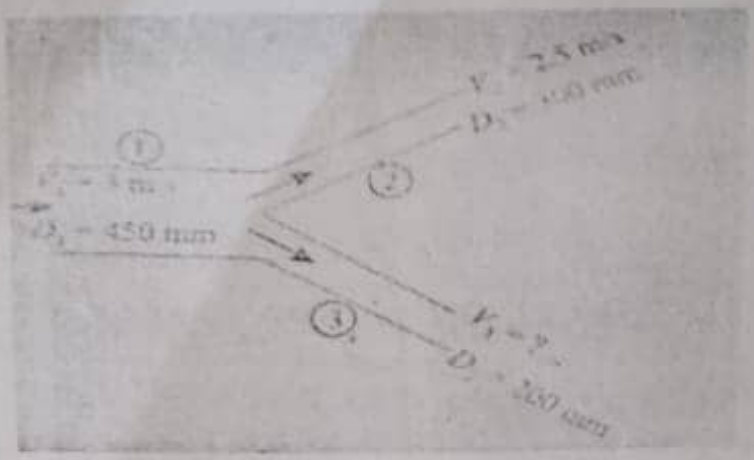

Figure 2

c) Find the height of water column corresponding to the pressure of 72 kN/m^2

QUESTION FIVE

a) List 6 types fluid flow.

b) Define the following terms i) Total pressure ii) stable and neutral equilibrium.

c) The following data relates to a conical tube of length 3.0 m fixed vertically with its smaller end upwards and carrying fluid in the downward direction. The velocity of flow at the smaller end is 10 m/s and 4 m/s at the larger end.

The loss of head in the tube = $\frac{0.4(V_1 - V_2)^2}{2g}$ where V_1 and V_2 are velocities at the smaller and larger ends respectively. Pressure head at the smaller end is 4 m of liquid. Determine the pressure head at the larger end.

QUESTION SIX

a) Water is flowing through a tapering pipe having diameters 300 mm and 150 mm at section 1 and 2 respectively. The discharge through the pipe is 40 litres/sec. The section 1 is 10 m above the datum and section 2 is 6 m above datum. Find the intensity of pressure at section 2 if that at section 1 is 400 kN/m^2.

b) Determine the dimensionless parameters of the underlisted Fluid Mechanics dimensions

i) Discharge

ii) Kinematic viscosity

iii) Pressure

iv) Modulus of elasticity

v) Volume

vi) Work

vii) Power

viii) Gravity

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FEDERAL UNIVERSITY OYE-EKITI
DEPARTMENT OF MECHANICAL ENGINEERING
2017/2018 B.Eng. DEGREE EXAMINATIONS

Course Code: MEE206
Course Title: Fluid Mechanics I
Units: 2
Instructions: Answer Any FOUR (4) Questions.
Time Allowed: $2\frac{1}{2}$ Hours

QUESTION 1

(a) What is a fluid?

(b) Air has a dynamic viscosity of $1.78 \times 10^{-5}\ kg/m.s$ and a density of $1.225\ kg/m^3$. Calculate its kinematic viscosity.

(c) (i) Write the Newton's law of viscosity given for one-dimensional flow.

(ii) An infinite plate is moved over a second plate on a layer of liquid. For a small gap width, d, we assume a linear velocity distribution in the liquid. If the dynamic viscosity of the liquid is $1.08\ kg/m.s$, the small gap, d, between the two plates is 0.0003m and the speed, u, at which the upper plate is moving over the stationary second plate is 0.3 m/s. Reasoning from the equation you have written in (c)(i) above, calculate the shear stress on the upper plate in N/m^2.

(b) Water flows through pipes A and B (refer to Fig. Q1). Oil with specific gravity 0.85, is in the upper portion of the inverted U. Mercury (specific gravity 13.63) is in the bottom of the manometer bends. Determine the pressure difference, $p_A - p_B$.

QUESTION 2

(a) Write the basic equation of fluid statics in vector form and indicate the physical significance of each term.

(b) Write the basic pressure-height relation for a static fluid and integrate it to determine the pressure variation for any given fluid property variation.

(c) The manometer shown, (refer to Fig. Q2), contains water and kerosene. With both tubes open to the atmosphere, the free-surface elevations differ by $H_0 = 20.0mm$. Determine the elevation difference when a pressure of 98.0Pa (gage) is applied to the right tube.

QUESTION 3

Consider a plane submerged surface with free surface at atmospheric pressure. Using the notation of Fig. Q3:

(a) Show that the hydrostatic force on the upper face of any plane submerged surface is equal to the pressure at the centroid times the area of the surface;

(b) Derive expressions for the coordinates of the center of pressure in terms of the geometric parameters of the surface

QUESTION 4

a) Define the following terms as applied to fluid mechanics:
(i) boundary layer and (ii) streamline.

b) Derive equation for an ideal fluid flow.

c) Find the velocity of flow, the discharge and the absolute pressure at crest level of a siphon with a uniform circular bore of 80 mm diameter and consisting of a bent pipe with its crest 2 m below water level if the atmospheric pressure is equivalent to 10 m of water. Neglecting losses due to friction.

QUESTION 5

a) Define the following terms as applied to fluid mechanics:
(i) adiabatic flow and (ii) volumetric flow rate

b) Derive continuity equation from the general principle of conservation of mass

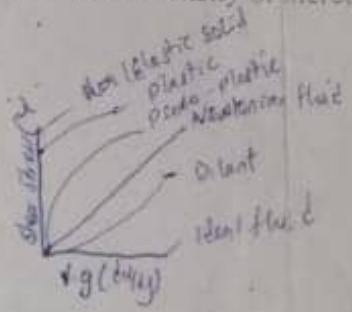
c) If 945 dm^3 of water are discharged from a vessel in 15 seconds, find the rate of discharge in m^3/s. If the discharge took place through an opening 120 mm diameter, determine the velocity of discharge.

QUESTION 6

a) Define the following terms as applied to fluid mechanics:
(i) potential and (ii) pressure head.

b) What is a control volume?

c) A venturi meter is introduced in a horizontal pipeline carrying water under a pressure of 120kNm^2, if the horizontal pipe has a diameter of 400 mm. the throat diameter of the meter is 100 mm and the pressure at the throat is 600 mm of mercury below atmosphere. Determine the flow rate in the pipeline if 2% of the differential pressure is lost between inlet and throat. Take the relative density of mercury to be 13.5.



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FEDERAL UNIVERSITY OYE-EKITI
FACULTY OF ENGINEERING
DEPARTMENT OF MECHANICAL ENGINEERING

2015/2016SECOND SEMESTER EXAMINATION

COURSE TITLE: Fluid Mechanics I CODE: MEE206
TIME ALLOWED: 2 Hours UNITS: 2.0
CLASS: 200 Level
INSTRUCTIONS: Answer any FOUR questions. All questions carry Equal marks.
Density of water = 1000 kg/m^3 and g = 9.81 m/s^2.

QUESTION ONE

(a) Define the following terms indicating their units as related to fluid
- (i) Compressibility;
- (ii) Specific gravity;
- (iii) Surface tension; and
- (iv) Relative Density.

(b) Calculate the density of air when the absolute pressure and the temperature are respectively 140 kPa and 50^{0}C and R = 287 J/kgK

(c) Air has a dynamic viscosity of 1.78 x 10^{-5}kgm^{-1}s^{-1} and a density of 1.225 kgm^{-3}. Calculate its kinematic viscosity.

QUESTION TWO

(a) Explain the following terms:
- (i) Atmospheric pressure;
- (ii) Gauge pressure;
- (iii) Absolute pressure; and
- (iv) Vacuum.

(b) Calculate the gauge pressure and the absolute pressure in kNm^{-2} at a point 3 m below the free surface of a liquid having a density of 1530 kgm^{-3} if the atmospheric pressure is equivalent to 750 mm of mercury and the density of mercury is 13600kgm^{-3}.

(c) A manometer connected to a pipe in which a fluid is flowing indicates a negative gauge pressure head of 75mm of mercury. Calculate the absolute pressure in the pipe in Nm^{-2}, if the atmospheric pressure is 1 bar and the density of mercury is 13600kgm^{-3}.

QUESTION THREE

(a) A rectangular block of wood floats in water with 50 mm projecting above the water surface. When placed in glycerin of relative density 1.35, the block projects 75 mm above the surface of glycerin. Determine the relative density of the wood

(b) A tank contains both oil and water. The oil has a depth of 1.5 m and a relative density of 0.8. It floats on top of the water with which it does not mix. The water has a depth of 2.0 m and the base of the tank is 3.0 m by 1.8 m. If the tank is open at the top to the atmosphere, calculate the total:
- (i) weight of the contents of the tank;
- (ii) pressure at the base of the tank; and
- (iii) force on the 3.0 m long side of the tank.

QUESTION FOUR

(a) Define the following terminologies:

(i) Buoyant force;

(ii) Centre of buoyancy; and

(iii) Centre of pressure.

(b) Figure Q4 shows a differential manometer connected at point A and B. At A, air pressure is 100kN/m^2. Find the absolute pressure at B.

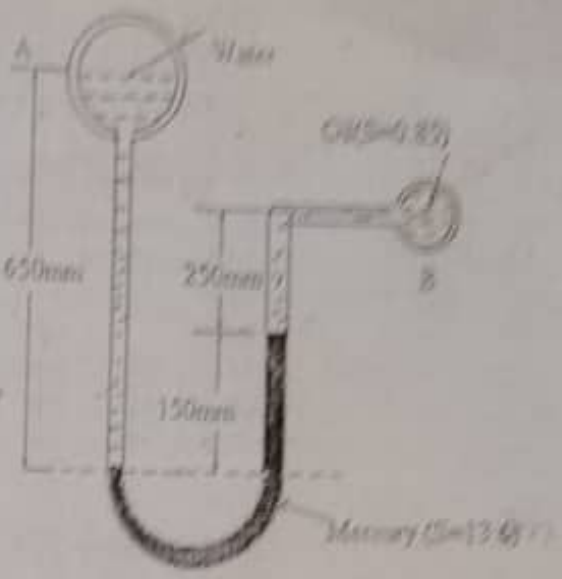


Figure Q4.

QUESTION FIVE

(a) Water flows through a pipe line of 0.8 m diameter at point 'A' and then branches into two pipes, one branch being 0.5 m diameter discharging at 'B' and the other branch 0.4 m diameter discharging at 'C'. If the velocity at 'A' is 3 m/s and the velocity at 'B' is 4.5 m/s, determine the discharge (volumetric flow rate) at A, B and C, and the velocity at C.

(b) Given that the density (ρ) of air varies linearly against height (h) above the earth's surface according to equation $\rho = 1.16 - (0.29 \times 10^{-3})h$, calculate the pressure on the earth's surface due to a column of air 390 m high.

QUESTION SIX

A body is immersed in a fluid at an angle 0 to the free surface. With the aid of a well labelled diagram, Show that the centre of pressure x_p on the body equals $\frac{I_G}{Ax_G} + x_G$ i.e. $x_p = \frac{I_G}{Ax_G} + x_G$, where I_G is the second moment of area A about the centre of gravity and x_G is the inclined distance between the centres of gravity of the body and the free surface.

FEDERAL UNIVERSITY OYE-EKITI
FACULTY OF ENGINEERING
DEPARTMENT OF MECHANICAL ENGINEERING
2020/2021 SECOND SEMESTER EXAMINATION

COURSE TITLE: Fluid Mechanics I **CODE:** MEE 206
TIME ALLOWED: 2 Hours **UNITS:** 2.0
CLASS: All Level Two Engineering and WMA
INSTRUCTIONS: Attempt any four questions

QUESTION ONE

a) By Definition, bulk modulus $K = -V(\frac{dP}{dV})$, proof that $K = P\gamma$ *5 marks*

b) The density of oil at 20^0C is 850 kgm^{-3}. Find its relative density and kinematic viscosity if the dynamic viscosity is 0.005 $kgm^{-1}s^{-1}$. *5 marks*

c) A U-tube manometer is arranged as shown in Figure 1, to measure the pressure difference between two pipelines A and B, both carrying water of density 1000kg/m^3. The density of manometric fluid is 13,600kgm^{-3}. Calculate the pressure difference if h_1 is 2.4 m, h_2 is 1.6 m and h is 1.4 m.

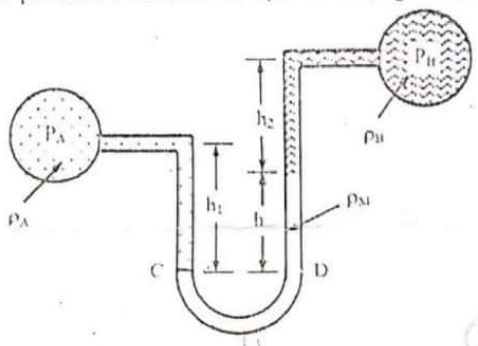


Figure1 *5 marks*

QUESTION TWO

a) Explain the following terms in relation to shear stress Dilatant substances, Viscoelastic materials and Thixotropic substances *6 marks*

b) Define the following terms
i. Fluid ii) Bulk Modulus of Elasticity iii) Isentropic process *6 marks*

c) State two Distinctions between a solid and a fluid in relation to elastic limit *4 marks*

d) With the aid of diagram explain the capillary phenomenon. Hence show that $h = \frac{4\sigma\cos\theta}{\omega d}$ *4 marks*

QUESTION THREE

a) The compression and expansion of gases takes place according to various laws of thermodynamics. **Isothermal process:** is a constant temperature process and is characterized by Boyle"s law. Show that K = P *7 marks*

b) A cylinder contains 0.35m^3 of air at 50^0C and 2.76 bar. The air is compressed to 0.071m^3. Assuming isentropic condition, what is the final pressure and temperature, and what is the bulk modulus of elasticity ($\gamma = 1.4$)? *8 marks*

c) With the aid of a diagram explain the principle of Inverted U-Tube manometer *5 marks*

QUESTION FOUR

a) For the hydraulic jack show in Fig 2 below. Find the load lifted by the large piston when a force of 400 N is applied on the small piston. Assume the specific weight of the liquid in the jack is 9.81 kNm^{-3} *5 marks*

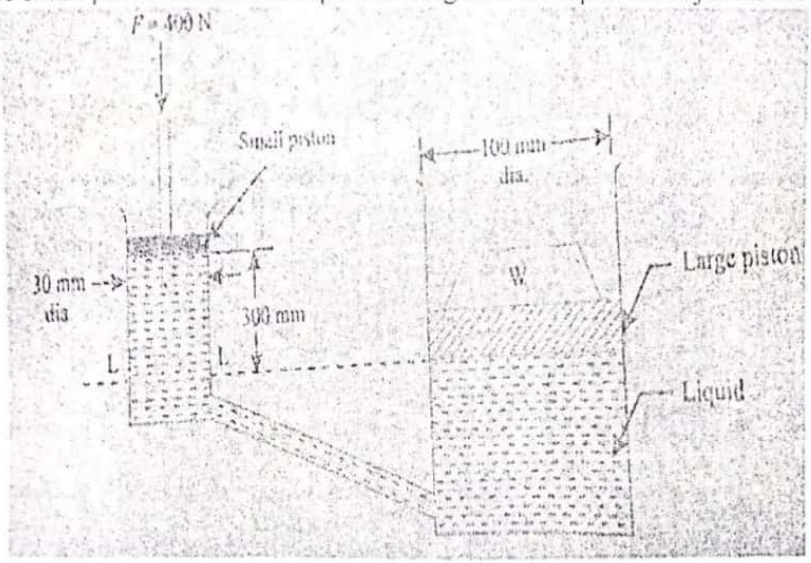


Figure2

b) Stratified fluids are two or more fluids of different densities, which float on the top of one another without mixing together. Proof mathematically that the total weight exerted by the fluids is equal to the product of the area and total pressure. *7 marks*

c) Derive the Continuity Equation as it relates to fluid. *6 marks*

QUESTION FIVE

a) With the aid of graph show the relationship of shearing stress versus shearing strain for 6 various types of fluids. *6 marks*

b) Define the following terms i) Total pressure ii) stable and neutral equilibrium. *3 maks*

c) Air is compressed to 0.096 m^3 in a cylinder containing 0.48 m^3 of air at 50^0C and 2.8 bar.
(i) Assuming isothermal conditions, what is the pressure at the new volume and what is the bulk modulus of elasticity?
(ii) Assuming isentropic conditions, what is the final pressure and temp, and what is the bulk modulus of elasticity? Given that $\gamma = 1.4$ *11 marks*

QUESTION SIX

a) Consider the motion of a high viscous fluid illustrated in Figure .2, the fluid is confined between two parallel plates by a small distance y. The lower plate is stationary while the upper plate is moving with velocity U. The upper plate is acted upon by a constant force F and thus moves at a constant velocity U. Because of adhesion, the fluid in contact with the upper plate moves with the same velocity as the plate, whereas the fluid in contact with the stationary plate has a velocity equal to zero. A velocity gradient is thus set up in the fluid. Experiments have shown that the force F varies with the area of the plate A, with velocity U and inversely with distance y.
Proof that the dynamic viscosity, $\mu = \frac{Force \times Time}{Area}$ *12 marks*

b) Find the change in volume of 2.00 m^3 of water at 26.7^0C when subjected to a pressure of 1.0 bar and bulk modulus of elasticity is 2.24 GNm^{-3} *4 marks*

c) From the following test data, determine the bulk modulus of elasticity of water at 30 bar, the volume was 1.00 m^3 and at 180 bar, the volume was 0.99 m^3 *4 marks*

FEDERAL UNIVERSITY OYE-EKITI
FACULTY OF ENGINEERING
DEPARTMENT OF MECHANICAL ENGINEERING

2018/2019 FIRST SEMESTER EXAMINATION

COURSE TITLE:	Fluid Mechanics I	CODE:	MEE206
TIME ALLOWED:	2 Hours	UNITS:	2.0
CLASS:	200 Level		
INSTRUCTIONS:	Answer any FOUR questions. All questions carry Equal marks.		

QUESTION ONE

(a) State Newton's law of viscosity (5marks)
(b) What do you understand by Newtonian fluid? (5marks)
(c) Define kinematic viscosity (5marks)
(d) Find the expression for isothermal bulk modulus of elasticity for a gas which obey's Vander waals law of state in accordance to the equation below. Where p, ρ, R, T have the normal meaning and c, e are constants.

$$p = \left[\frac{1}{1-c\rho} - \frac{e\rho}{RT}\right]\rho RT \qquad \text{(10 marks)}$$

QUESTION TWO

(a) State the differences between cohesion and adhesion (5marks)
(b) What do you understand by capillarity? (5marks)
(c) Derive Bernoulli's equation which takes into consideration that energy can be supplied or removed from the fluid from appoint to another (15marks)

QUESTION THREE

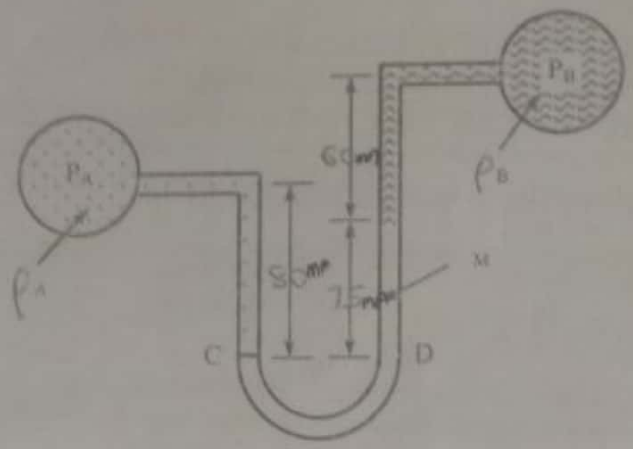
(a) State five advantages of manometer (5marks)
(b) State five limitations of manometer (5marks)
(c) Find the velocity of flow, the discharge and absolute pressure at crest level if the atmospheric pressure is equivalent to 10 m of water. Neglecting losses due to friction of a siphon with uniform circular bore of 75 mm diameter and consisting of a bent pipe with its crest 3.6 m above water level discharging into the atmosphere at the level 1.8 m below water level. (15marks)

QUESTION FOUR

(a) A differential manometer connected at two points A and B. At A air pressure is 100kN/m^2. Find the absolute pressure at B. Where specific gravity of oil is 0.85, mercury is 13.6. (10 marks)
(b) Calculate the volume flow rate of fluid if the total energy per unit weight is 340 N/s with density of 12.3 and energy per unit time of 50 kW (10marks)
(c) What is gauge pressure? (5marks)

QUESTION FIVE

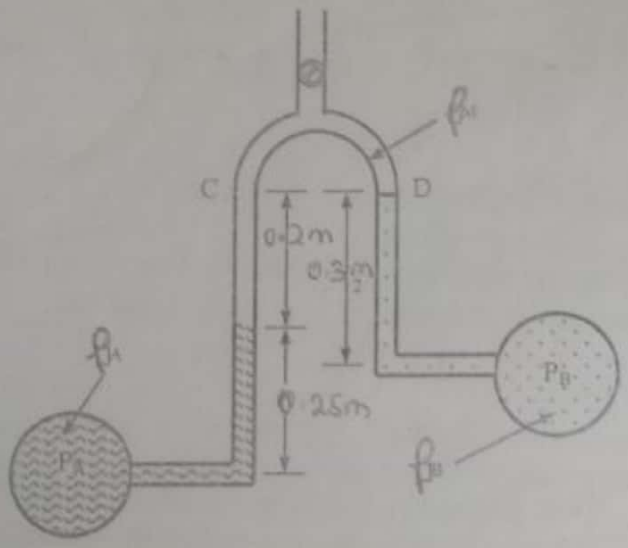
(a) What is the difference between absolute and atmospheric pressure? (5marks)
(b) What is metacentre? (5marks)
(c) What is metacentric height? (5marks)
(d) A U-tube manometer is arranged as shown below in figure 1, to measure the pressure differences between the pipelines X and Y both carrying a liquid of density 1750 kg/m^3. The density of the manometric fluid is 27,500 kg/m^3. Calculate the pressure difference. (10 marks)



QUESTION SIX

(a) What is control volume? (5marks)

(b) State the difference between stable and neutral equilibrium (5marks)



(c) An inverted U-tube as shown above, to measure pressure difference between two points A and B. Fluid A is water and the top of manometer is filled with oil of relative density 0.75. Calculate the pressure difference (a) when fluid B is liquid of relative density 0.8 and (b) when fluid is water (c) what will be the pressure difference in (a) and (b) when the top of manometer is filled with air instead of oil. (15marks)