# TECHNICAL UNIVERSITY OF MOMBASA

## Faculty of Engineering and Technology

## DEPARTMENT OF MECHANICAL AND AUTOMOTIVE ENGINEERING
DIPLOMA IN MECHANICAL ENGINEERING (PLANT OPTION)

### EME 2106
MECHANICAL ENGINEERING SCIENCE II

END OF SEMESTER EXAMINATIONS

YEAR 1 SEMESTER 2

**SERIES:** DECEMBER, 2013

**TIME:** 2 HOURS

**INSTRUCTIONS TO CANDIDATES:**

1.   You should have the following for this examination:
   - Answer Booklet
   - Scientific Calculator

2.   This paper consists of **FIVE** Questions.
3.   Answer **ANY THREE** Questions.
4.   All Questions carry equal marks.
**This paper consists of FOUR printed pages.**

Question ONE

(a)     Define a fluid. Give any **THREE** differences between a liquid and a gas.          **(4 marks)**

(b)     (i)     A rectangular tank 68m long and 15m wide is filled with oil to a depth of 4m.  What is
$$\left(\rho_{oil} = 800kg/m^3\right)$$
the total thrust of the oil on the bottom of the tank?                                          .

        (ii)    What is the gauge pressure on a submarine 75m below the surface in sea water of
                density 1.00g/cm³.

        (iii)   In the figure below what is the absolute pressure of the manometer shown. The
$$\left(\rho_{mercury} = 13600kg/m^3\right)$$
                manometric fluid is mercury and G = 30mm.
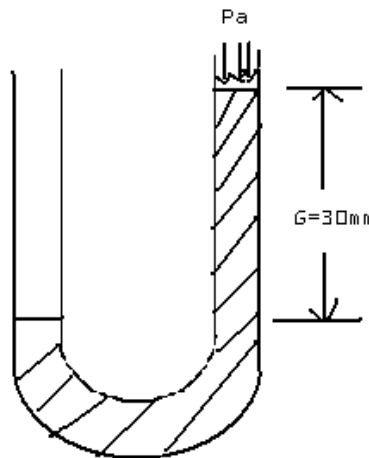


                                                                                                **(16 marks)**


**Question TWO**

(a)     (i)     Define friction force.                                                          **(2 marks)**

        (ii)    Give any **THREE** laws of friction.                                            **(3 marks)**

(b)     An inclined plane is of length 4.5m and height 2.5m.  A body of weight 10N is on the plane
        and a force of 3N acting along the plane just prevents the body from sliding down the plane.

        (i)     Find the coefficient of limiting friction between the plane and the weight.
        (ii)    Calculate the least force parallel to the plane required to pull the weight up the plane.
        .                                                                                       **(12 marks)**

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**Question THREE**

(a)     Define the following terms as applied to heat energy:

      **(i)**     (I)      Specific heat capacity
               (II)    Specific latent heat of fusion

      **(ii)**    (I)      State the **THREE** temperature scale
            **(II)**   State **THREE** modes of heat transfer

                                                                         **(8 marks)**

(b)     Calculate the amount of heat energy required to convert 1.5kg of ice at 250k to 373k.  Take:
      Specific heat capacity of water as 4.2kJ/kgk
      Specific latent heat of fusion of ice as 335kJ/kg
      Specific latent heat of vaporization of water as 2250kJ/kg

                                                                       **(12 marks)**

**Question FOUR**

(a)     A bar 5m long is made up of two materials, joined in series.  The first is 1.7m long of brass material and $7.5cm^2$ in cross section.  The second is steel and is $6.0cm^2$ in cross section.  The bar is in tension under a load of WN, and the total elongation is 0.12cm.  Taking $E_s = 200GN/m^2$ and $E_b = 80GN/m^2$.  Determine:

      (i)     The extension for each material
      (ii)    The load W.

                                                                          **(10 marks)**

(b)     An engine exerts a force of 35KN on a train of mass 240 tonne and draws it up a slope of 1 in 200 against a resistance of 60N.  Find:

      (i)     The acceleration of the train.
      (ii)    The braking force required on the return journey to prevent the acceleration exceeding $0.01m/s^2$.

                                                                          **(10 marks)**

**Question FIVE**

A simple machine used for lifting was under test and gave the following results:

| Load W(N) | 250 | 500 | 750 | 1000 | 1500 | 2500 |
|-----------|------|------|------|------|-------|------|
| Effort P(N) | 42.5 | 62.5 | 82. | 105 | 142. | 220 |

| | | | 5 | | 5 | |
|---|---|---|---|---|---|---|

The velocity ratio of the machine is 18.

**(i)**    Plot a graph showing the relation between effort and load.
**(ii)**    Determine law of the machine.
**(iii)**    Determine the effort and efficiency for a load of 25KN.
**(iv)**    Find the maximum efficiency.
**(v)**    Find the effort to overcome machine friction when the load is 2kN.

**(20 marks)**