THE MOMBASA POLYTECHNIC UNIVERSITY COLLEGE

FACULTY OF ENGINEERING & TECHNOLOGY

DEPARTMENT OF MECHANICAL AND AUTOMOTIVE ENGINEERING

DIPLOMA IN MECHANICAL ENGINEERING (PLANT OPTION)

EEP 2241 PLANT ELECTRICAL

YEAR II SEMESTER II

SUPPLEMENTARY/SPECIAL EXAMINATION

TIME: 2HRS

INSTRUCTION TO CANDIDATES

You should have the following for this examination

- ➢ Scientific Calculator
- ➢ Answer booklet

This paper consists of **FIVE** questions in two sections; A and B.

Answer question **ONE** and any other **TWO** question from section B

Maximum marks for each part of a question are as shown.

SECTION A (Compulsory)

1. a)
    i. Explain the three methods of temperature control of the resistance furnaces.   (5mks)
    ii. A domestic consumer requires an immersion heater for a tank containing 160litres of water. The water is to be heated from 10°C to 50°C in three hours. Calculate the nearest element size in KW if the efficiency of the heating system is taken as 85%.(take 1litre of water is equivalent to 1 kilogramme)   (3mks)
    iii. Explain the effect of increasing the thickness of refractory walls of furnaces.
            (2mks)

   b)
    i. If P is the power input, and H is the heat dissipated by radiation, show by first principle that as per Stephan's law of radiation that:

$$\frac{l}{d^2} = \frac{\pi V^2}{4\, l\rho}$$

            (5mks)
    ii. Explain why industrial tariffs include a charge per KVA of maximum demand.
            (2mks)
    iii. It is usual for power, factor correction capacitors to be near as possible to the equipment which causes low lagging power factor. Explain.
            (3mks)

SECTION B (Answer any two questions in this section)

2. a)
    i. Define heating.
            (1mks)
    ii. Explain the principle of induction heating. State applications of induction heating.
            (3mks)
    iii. State any four advantages of induction heating over conventional methods of heating in industries.
            (4mks)
    iv. Explain four advantages of electric heating.
            (4mks)
    v. With the aid of a cross-sectional diagram, explain the construction of metal rectifiers element of selenium type and indicate clearly the permitted direction of the current flow.
            (3mks)

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b)

   i.   An insulating material 2cm thick and 200cm² in area is to be heated by
        dielectric heating. The material has relative permittivity of 5 and power
        factor of 0.05. Power required is 400W and frequency of 40MHz.
        Calculate the voltage and current that will flow through the material. If
        the voltage is limited to 700V, calculate the frequency to get the same
        loss. (3mks)
   ii. State four applications of dielectric heating.
             (2mks)

3. a)
   i.   A resistance oven employing nichrome wire is to be operated from 220V
        single phase supply and is to be rated at 16kW. If the temperature of the
        element is to be limited to 1,170°C and average temperature of charge is
        500°C, calculate the diameter and length of the element wire. (take radiating
        efficiency=0.57, emissivity=0.9, specific resistance of nichrome=$109×10^{-8}$.
                                                                        (6mks)
   ii. Define:
             a. fixed costs
             b. running/operating costs
             c. iii)two part tarrif

        Give examples of each of the above.
        (6mks)

b)

   i.   State factors influencing costs and tariffs of electric supply.
                     (3mks)
   ii. A factory takes a load of 20kW at 0.85 power factor lagging for 2500hours
        p.a. and buys energy on tariff of Kshs.150 per kVA plus Kshs. 6 per kWh
        consumed. If power factor is improved to 0.9 lagging by means of a capacitor
        costing shs. 525 per KVA and having a power factor of 100W per KVA,
        Calculate the annual saving affected by their use. Allow 8% p.a for interest
        and depreciation on the capacitors.   (7mks)

4. a)
   i.   Explain the difference between core type and coreless induction furnace
        heating.
                     (3mks)
   ii. Using a well labeled diagram, explain the operation of the direct arc funaces
                (5mks)

   b)

i. Define power factor.
        (3mks)

ii. A factory has a maximum demand of 200KVA when operating a power factor of 0.7 lagging. If power factor improvement equipment is installed to give a power factor of 0.95, calculate the annual saving in the electricity charge? What will be the total electricity charge in one year after the power factor has been improved if the factory has a load factor of 50%. The tariff is Kshs. 8.75 per kVA of maximum demand per year plus 0.5 per unit consumed.
        (5mks)

iii. Explain two methods of heat transfer.
        (2mks)

5. a)
    i. State five requirements for a good heating element.
            (5mks)
    ii. State three limitations of low power factor.
            (3mks)
    iii. Define load factor.
            (2mks)

   b)
    i. With the aid of a circuit diagram and waveforms, explain the term phase control as applied to controlled rectification.
                (7mks)
    ii. State any three applications of silicon controlled rectifiers.
            (3mks)