

BINDURA UNIVERSITY OF SCIENCE EDUCATION

FACULTY OF SCIENCE AND ENGINEERING

AEH 103

Department Of Engineering and Physics
Bachelor of Science (Honours) Agricultural Engineering Part I Examination
Electrical and Electronic Principles

3 HOURS (100 MARKS)

INSTRUCTIONS

Answer any **FOUR** questions. Each question carries 25 marks.

Question 1

- A wire of uniform cross section has a resistance of 1.2Ω . Find its resistance when the length of the wire is doubled and its cross-sectional area increased 3 times. [5 marks]
- A Diesel-electric generating set supplies an output of 40 kW and the calorific value of the fuel oil used is 7,500 kcal/kg. If the overall efficiency of the unit is 47% calculate:
 - the mass of oil required per hour, [5 marks]
 - the electric energy generated per tonne of the fuel. [5 marks]
- With reference to electric current and convectional current, explain the significance of the electron theory in the study of electricity. [10 marks]

Question 2

- It is given that you are required to design a heating element to boil 2 kg of water in 3 minutes using 150 kilojoules of energy. If the heating element is to operate at 240V, calculate:
 - its power rating, [3 marks]
 - its current. [3 marks]
- A d.c. electromagnet wound with 1200 turns has a resistance of 85Ω when the exciting voltage is 240 V and magnetic flux is 0.009 Wb. Calculate:
 - the self-inductance of coil, [3 marks]
 - the energy stored in the magnetic field. [3 marks]
- A factory has a 240-V supply from which the following loads are taken:

Lighting: one hundred 100-W, two hundred 85 W and four hundred 50 W lamps
Heating: 180 kW
Motors: a total of 50 kW with an average efficiency of 65%
Misc.: various load taking a current of 48 A.

Assuming that the lighting load is on for a period of 6 hours/day, the heating for 12 hours/day and the remainder for 4 hours/day, calculate:
 - the weekly consumption of the factory in kWh when working on a 5-day week, [11 marks]
 - the total cost of electricity in a month (4 weeks) when unit cost is \$0.11/kWh. [2 marks]

Question 3

- A coil with 200 turns and of resistance 150Ω is placed in a magnetic field of 1.8 mWb and connected in series with a galvanometer of 350Ω resistance. When the coil is moved in $1/5$ th of a second from the given field to 1.1mWb, calculate:
 - the average e.m.f., [4 marks]
 - the current induced in the coil. [3 marks]
- Given that a capacitor draws 3.6 A of current at 240-V, 50 Hz, find:
 - the capacitive reactance [3 marks]

- ii. the capacitance. [3 marks]
- c. Explain, giving examples, the four factors that affect resistance in an alternating current (a.c) circuit. [12 marks]

Question 4

- a. Three coils each having resistance 4.5Ω and inductive reactance 6.5Ω are connected (a) in star and (b) in delta to a 415V , three-phase supply. Calculate, for each connection, line and phase:
- i. Voltages, [5 marks]
 - ii. currents. [5 marks]
- b. With the aid of balanced equations, describe the chemical changes that take place during discharging and charging of a lead acid battery. [5 marks]
- c. Given that a 12Ω resistor in series with a 16.38 mH inductor is connected across a 240-V , 50-Hz source, determine:
- i. the total impedance, [3 marks]
 - ii. the input current, [1 mark]
 - iii. the voltages across the resistor and inductor, [2 marks]
 - iv. the power factor, [2 marks]
 - v. the power consumed by the circuit [2 marks]

Question 5

- a. Obtain the Norton's equivalent across the terminals A and B of the circuit in Fig. 1. [6 marks]

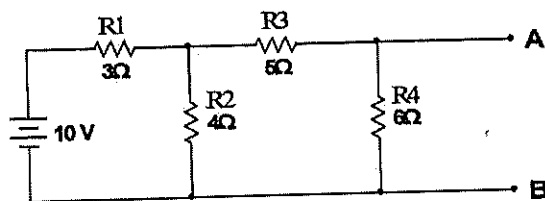


Figure 1: Combined electrical circuit with one power source

- b. Obtain the Thevenin's equivalent across the terminals X and Y of the circuit in Fig. 2. [6 marks]

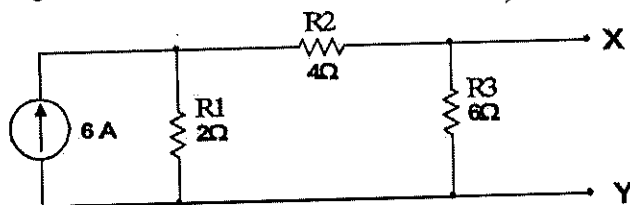


Figure 2: Combined electrical circuit with current source

- c. Use the superposition theorem to find the currents I_1 and I_2 in the circuit in Fig. 3. [13 marks]

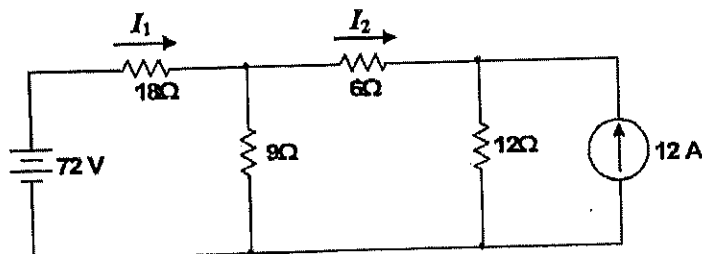


Figure 3: An electrical circuit with both current and e.m.f. sources

Question 6

- a. Briefly describe the operation of a p-n junction semi-conductor. [3 marks]

- b. Distinguish, giving appropriate examples, a combinational logic from a sequential logic. [4 marks]
- c. Simplify the following Boolean equations:
- i. $X = C.(A + \bar{B}.(D + E + \bar{C}) + \bar{B}.C) + A$, [7 marks]
 - ii. $Y = (ABC + C).(A + B).\bar{A}$, [5 marks]
 - iii. $Z = (A \bar{B}(C + BD) + A \bar{B}).C$ [6 marks]

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