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Examination for Authorisation B

Paper 1: **Theory**

Date: **02 February 2021**

Time: **15:00 – 18:00 (Three hours)**

This examination paper contains six questions. Candidates are requested to answer any FIVE (5) questions. Candidates are also requested to include all their work in the booklet provided. Every answer should include all workings, any necessary diagrams and formulae. Use a fresh page for each different question. Each question carries 20 marks.

1. When connected to a 220 volt, 50 Hz supply, an inductive circuit takes 5 Amperes but this current falls to 4.4 Amperes when 10 ohms are added in series.

   (a) Find the resistance of the circuit. **(10 marks)**
   (b) Find the inductance of the circuit. **(10 marks)**

2. A 440 volts synchronous motor takes 50 amperes at 0.9 p.f. lagging. Effective resistance of the armature is 0.8 ohm. If the iron and friction losses are 600 watts find:

   (a) Find the horse-power (h.p.) output. **(10 marks)**
   (b) Find the efficiency of the motor if the excitation losses are 800 watts. **(10 marks)**

3. (a) The input power to a Delta connected three-phase 400V 50Hz induction motor was measured by the Two Watt-Meter method. The instrument readings were 30kW and 15kW respectively. Draw a clearly illustrated diagram showing how the motor and the watt-meters are connected for the test. **(4 marks)**

   (b) Calculate:

   i) the total power in kW taken by the motor **(2 marks)**
   ii) the power factor (p.f.) of the motor **(4 marks)**
   iii) the Apparent Power (kVA) of the circuit **(2 marks)**
   iv) the line current **(3 marks)**
   v) the phase current **(2 marks)**

   (c) What does the fact that one of the Watt-Meters is reading negatively indicate? **(3 marks)**

4. (a) What is the advantage of connecting the low voltage winding of a transformer in Star connection? **(4 marks)**

   (b) The primary and secondary windings of a 500kVA transformer have resistances of 0.42 ohm and 0,0024 ohm respectively. The primary and secondary voltages are 3300V and 400V respectively and the iron losses after performing an open circuit test were found to be 1.5kW.

   Assuming that the load supplied by the transformer has a power factor of 0.8 lagging. Calculate the efficiency of the transformer:

   i. on full load **(8 marks)**
   ii. on half load **(8 marks)**

5. Referring to resistance and resistivity:

   (a) The resistance of an electrical conductor depends mainly on four factors. List and explain these four factors. **(6 marks)**

   (b) What is the resistance relationship for each factor? With the aid of examples describe what is meant by resistivity and its importance. **(4 marks)**

   (c) A coil of copper wire has a resistance of 205 ohm when its mean temperature is 0°C. Calculate the resistance of the coil when its mean temperature is 82°C. Take the temperature coefficient of resistance of copper to be 4.28×10^{-3}/°C referred to 0°C. **(4 marks)**

   (d) When a potential difference of 12 V is applied to a coil of copper wire of mean temperature 18°C, a current of 1.4 A flows in the coil. After some time the current falls to 1.25 A, yet the supply voltage remains unaltered. Determine the mean temperature of the coil given that the temperature coefficient of resistance of copper is 4.28×10^{-3}/°C referred to 0°C. **(6 marks)**

6. (a) With the aid of diagrams define Kirchhoff's Laws. **(4 marks)**

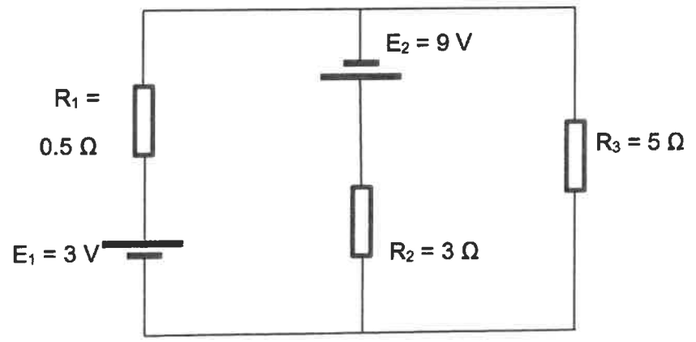

Figure 1

   (b) Using Kirchhoff's laws determine each branch current for the network shown in Figure 1.

   $R_1 = 0.5$ ohm, $R_2 = 3$ ohm, $R_3 = 5$ ohm and the battery voltages of $E_1 = 3$ V and $E_2 = 9$ V respectively.

   Calculate the following:

   (i) the current through R_1, **(6 marks)**
   (ii) the current through R_2 and **(6 marks)**
   (iii) the current through R_3. **(4 marks)**

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