GOVERNMENT OF MALTA
MINISTRY FOR EDUCATION, SPORT, YOUTH
RESEARCH AND INNOVATION
DEPARTMENT OF EXAMINATIONS

EXAMINATION FOR AUTHORISATION B

Paper 1

Date: **2nd July 2024**

Time: **16:00 – 18:00 (Two hours)**

This examination paper includes ten questions. Candidates are requested to answer ALL questions clearly indicating the question number of the answered questions.

Write only your Index Number in the space provided in the booklet.

Candidates are requested to answer ALL questions in the booklet correctly listing the answered question number in the space provided on the booklet's front sheet.

Answers should be written in Blue/Black ink. Diagrams can be drawn in pencil.

All answers should include the necessary workings, diagrams and formulae.

Use a separate page for each different question.

Each question carries 10 marks.

1. A coil of 0.12 H is connected in series with a 60-ohm resistor across a 110 V 50 Hz supply.
   (a) On the answer booklet provided draw the RL circuit. **(1 mark)**
   (b) Calculate:
      (i) the reactance of the coil. **(3 marks)**
      (ii) the impedance of the circuit and **(3 marks)**
      (iii) the current taken from the supply. **(3 marks)**

   (10 marks)

2. (a) State the **FOUR** factors affecting the resistance of a conductor. **(4 marks)**

   (b) The resistance of a coil, made of aluminium wire, is 200 ohms at 18^{o} C. Due to the working conditions, the temperature of the coil increased, and the resistance was measured to be 250 ohms. Assume that the temperature coefficient of resistance of aluminium is 0.0039/^{o} C at 18^{o} C, calculate the temperature of the coil when the resistance was 250 ohms. **(6 marks)**

   (10 marks)

3. The IET Regulations recommend that every consumer's installation, single or three-phase, should have a means of isolation. This should include a means of overcurrent protection and earth leakage protection. This recommendation applies for all type and size of any installation.

   (a) On the answer booklet provided draw a Single-phase protection and control diagram on the answer booklet provided. Your diagram should include all the necessary components. **(4 marks)**

   (b) On the answer booklet provided draw a three-phase protection and control diagram on the answer booklet provided. Your diagram should include all the necessary components. **(6 marks)**

   Both (a) and (b) diagrams should be well labelled. **(10 marks)**

4. (a) Explain why Power factor correction is very important in industrial electrical installations. **(2 marks)**
   (b) Explain how the power factor is calculated and give the formula. **(4 marks)**
   (c) Assume that a system has a real power of 12kW and an apparent power of 18 kVA. Calculate the power factor. **(4 marks)**

   (10 marks)

5. Regulation 17 within the local electrical installations regulations (S.L.545.24), mentions several requirements for temporary electrical installations, which the electrical authorised provider shall comply with. A private contractor requires a three phase and neutral installation for a construction site to supply a tower crane and electrical tools.

   (a) What is the minimum ***IP code*** required for the outdoor enclosure box to house the electrical switchgear? **(1 mark)**

   (b) What is the permissible maximum operating current rating of the ***main*** residual current type of device (RCD) used for earth leakage protection? **(2 marks)**

   (c) What is the permissible maximum operating current rating of the RCD required for earth leakage protection of hand and mobile tool circuits? **(2 marks)**

   (d) A three-phase delta connection 20kW hoist and 5kW carriage motors of a tower crane are required to be disconnected by a main 3-pole moulded case circuit breaker (MCCB). Calculate the rating of the MCCB used for overcurrent protection, if the voltage is 400 V ac 50 Hz. Assume that the power factor of the hoist motor and carriage motor is 0.8 lagging and 0.9 lagging, respectively. **(5 marks)**

   (10 marks)

6. An electrical installation, in hazardous chemical factory, is supplied from a three phase and neutral source having a TT earthing system. The Electrical authorised provider requires to balance various types of heavy loads.

(i) Describe the methods which are used to monitor and detect the three phase unbalanced loads (you are required to mention the type of instruments used). **(5 marks)**

(ii) What are the effects of the unbalanced loads at the main switchboard switchgear and the chemical factory electrical automated machines? **(5 marks)**

(10 marks)

7. (a) Define the *difference* between ***prospective short circuit current*** and ***the prospective earth fault current.*** **(2 marks)**

(iv) The main three-phase distribution has a faulty MCCB and needs to be replaced. The MCCB rating is 100A, type C, with a prospective short current rating of 6kA. The MCCB is replaced with a MCCB having a rating of 100A with a prospective short current rating of 2kA.

(i) Explain whether the replacement of the MCCB is correct. **(1 mark)**

(ii) Mention **TWO** effects which are caused by the incorrect replacement of the 100A MCCB if a fault happens and the prospective fault current to earth will be over 2kA but limited to 5kA. **(2 marks)**

(c) A 400 V, 50 Hz three-phase star connected machine develops a fault to earth in the control circuit which is connected to phase 1 and neutral. The data logger records an instantaneous current of 5kA flowing in the brown line. What is the earth fault contact impedance inside the machine? The outside impedance loop 0.02 ohms and supply conductor impedance to the machine is 0.021ohms. (assume unity p.f) **(5 marks)**

(10 marks)

8. (a) A moving coil meter has a resistance of 5 ohms and gives full scale deflection (FSD) at 15mA. If the instrument is required to measure current up to 3A.

(i) State what is required to install to achieve this function. **(2 marks)**

(ii) Calculate the value of the additional resistance required. **(2 marks)**

(iii) Calculate the resistance power rating. **(1 mark)**

(b) A moving coil instrument has a resistance of 5 ohms and FSD at 20mA. It is required to measure voltage up to 100 V.

(i) State what is required to install to achieve this function. **(2 marks)**

(ii) Calculate the value of the additional resistance required. **(2 marks)**

(iii) Calculate the resistance power rating. **(1 mark)**

(10 marks)

9. (a) A loop impedance test on a lighting circuit protected by a 6A type B MCB cannot be conducted and measured as the MCB keeps on tripping.

(i) Explain why this is taking place. **(3 marks)**

(ii) How can this problem be temporary solved to do the test? **(2 marks)**

(b) (i) What are harmonics currents in an electrical network? **(3 marks)**

(ii) In a polyphase circuit, harmonics tend to produce two of the following:

- Light energy in cables
- Very large magnetic fields that tend to destabilize earth magnetic field
- High neutral currents in Delta connected load and circulating currents in Star connected load.
- Opposite torque components in induction machines.
- Very high currents in PFC capacitors.

ONLY TWO of the statements above about a polyphase circuit are correct. In your answer booklet write the two correct statements. **(2 marks)**

(10 marks)

10. For agricultural installations, especially where livestock is present, IET BS7671 specifies lower values for earth fault loop impedance and lower disconnection times together with other requirements.

(a) List the reasons and benefits of these requirements for the agricultural installations. **(3 marks)**

(b) Draw a diagram to illustrate the earth fault loop impedance. **(2 marks)**

(c) What do you understand by the "disconnection time"? **(1 mark)**

(d) A 230 V ac single phase final circuit providing supply to an electronic equipment comprising an automatic milking machine is protected by a 6A type C, CB, BS EN 60898 characteristic, as shown in Figure 8.1

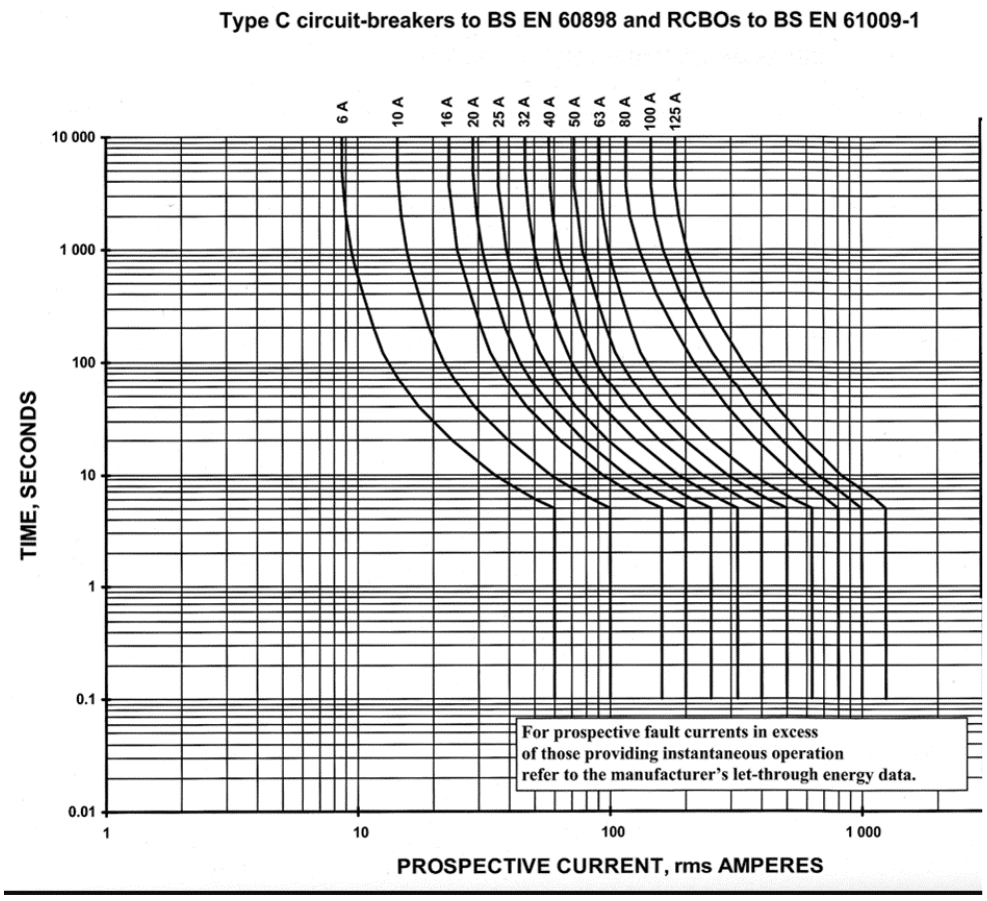

Figure 8.1

From the characteristic curves obtain the fault current for:

(i) 5 seconds **(1 mark)**

(ii) 0.2 seconds. **(1 mark)**

(e) If the measured Z_e value on this premises is approximately 90 ohms then,

(i) Is the phase to earth fault current enough to trip the type C breaker? **(1 mark)**

(ii) What additional protection equipment do you recommend installing for this TT system, to achieve the required protection disconnection times? **(1 mark)**

(10 marks)

END OF EXAMINATION PAPER