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GOVERNMENT OF MALTA
MINISTRY FOR EDUCATION
AND SPORTS

EXAMINATION FOR AUTHORISATION B

Paper 2

Date: Friday 3rd July 2026

Time: Three hours

Write <u>only</u> your Index Number in the space provided in the booklet.

This examination paper includes six questions. Candidates are requested to choose and answer any FIVE questions clearly indicating the question number of the answered questions.

Candidates are requested to answer ALL FIVE 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 20 marks.

1. (a) A copper field winding coil has a resistance of 120 Ω at an ambient temperature of 20°C. The temperature coefficient of resistance is 0.004 /°C.

Calculate the resistance of the winding at 60°C. (3 marks)

(b) A coil having an inductance of 40 mH is connected to a 230 V a.c. supply. Assuming that the inductance does not vary significantly with temperature, calculate the current through the coil when the temperature is:

i) 20°C (4 marks)
ii) 60°C. (4 marks)

(c) A farmhouse is supplied by three-phase underground cable from a nearby substation. The cable consists of four single core conductors. The route length between the substation and the farmhouse is 500m. Each single core conductor has an insulation resistance to earth of 15 Mega-ohms/m and a leaking capacitance of 200 pF/m. Assume that the series resistance and inductance of the cable are of negligible values along the length of the cable, hence the equivalent circuit per metre is reduced to a simple parallel circuit of resistance and capacitance.

For one single-core conductor of 0.5 km length, calculate the

i) resistance of the cable core. (3 marks)

ii) capacitance of the cable core. (3 marks)

iii) cable core leakage current if the three-phase supply voltage is 400V. (3 marks)

2. A commercial building used for the manufacturing of plastic products has the following loads operating simultaneously during production.

- Two induction motors driving conveyor belts. Each machine is rated at 2 kW, 0.88 power factor, 400 V, 50 Hz, and operates at full load.
- An additional load of 10 A per phase at 0.9 power factor lagging supplies the process heaters and discharge lamps used for factory lighting.

(a) i) Draw a phasor diagram showing the total current of the motors resolved into its two components. (4 marks)

ii) Draw a similar phasor diagram for the discharge-lamp and heater load. (4 marks)

iii) Calculate the total current. (4 marks)

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(b) You are provided with two machine units as shown in Figure 1. One unit is a single-phase capacitor start motor which is designed to rotate in both directions, the other unit is a three-phase induction motor.

Draw a forward/reverse control circuit diagram for the:

i) single-phase capacitor start motor (4 marks)

ii) three-phase induction motor. (4 marks)

Both diagrams must show the protection against short circuits and overload, interlocking to prevent simultaneous energisation of the forward and reverse contactors and the start and stop buttons for both directions.

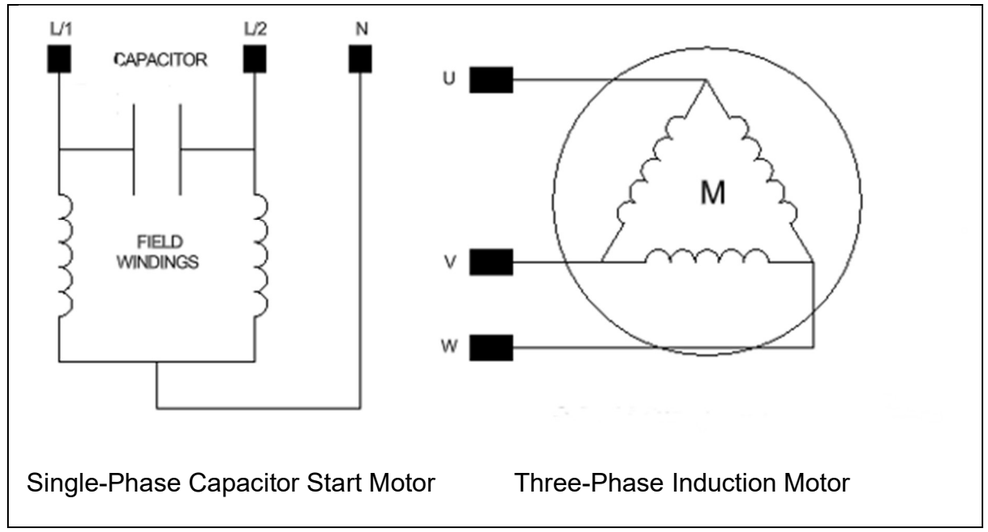


Figure 1

3. (a) Enemalta plc operates over 1,500 11 kV secondary substations within its radial distribution network. Identify and describe FIVE key primary components typically found in an 11 kV/400 V secondary substation. (10 marks)

(b) (i) Provide a technical overview of the TT earthing system, with particular reference to its application in Malta. Compare this arrangement with TN-S, TN-C-S, and IT systems, highlighting the fault path in each case. (6 marks)

(ii) Describe the statutory verification and testing procedures required for a new installation, including the measurement of earth electrode resistance and earth fault loop impedance (Zs). (4 marks)

4.(a) The primary risks of an incorrect maximum demand assessment include safety and cost.

List TWO reasons how incorrect maximum demand affects

(i) safety

(ii) cost. (6 marks)

(b) The inrush current of an electric motor is typically 6 to 8 times the full-load current. Identify THREE standard types of AC motor starter used in industrial installations. For each type, briefly explain its primary function in managing starting torque or protecting the electrical supply. (6 marks)

(c) Describe TWO key features for each of the industrial motor starters listed below:

(i) Direct online starter

(ii) Star-Delta starter

(iii) Autotransformer starter

(iv) Rotor Resistance starter. (8 marks)

5. A small factory reported an incident in which a person received an electric shock. The manager asked you to prepare a report of the incident. Following an investigation, it was found that the insulation of the grey phase conductor (line 3) had cracked and was in contact with the metal enclosure of the main switchboard. The factory is supplied with 400 V, three-phase, four-wire, 50 Hz, TT system.
Write a four-paragraph report on the incident using the following structure:

(i) First paragraph

Explain why the safety protection devices failed to operate. (5 marks)

(ii) Second paragraph

With the aid of a circuit diagram, explain the current path (no values required) and the voltage potential value from the main supply to the person receiving the shock. (5 marks)

(iii) Third paragraph

Explain how testing was carried out to identify the fault, and state the instruments used. (5 marks)

(iv) Fourth paragraph

Describe a planned maintenance programme that could be implemented to prevent a recurrence of the incident. (5 marks)

6 (a) **On your booklet** copy and complete the following table (Table 1) to indicate:

(i) the type of instrument used to measure the parameter
- ONE advantage
- ONE disadvantage. (12 marks)

Measure quantity	Type of instrument	One advantage	One disadvantage
Direct Current			
Alternating voltage			
Alternating current			
Power A.C. (active)			

Table 1

(b) A workshop is supplied by a 400 three-phase, four-wire, 50 Hz TT system. The authorised person is required to monitor the current, voltage and active power. The available instruments are: an ammeter with a full-scale deflection (f.s.d) of 5 A, a voltmeter with an f.s.d of 110V a.c. and a wattmeter rated 110 V a.c and 5 A f.s.d. Assume a power demand of 103 kW at unity power factor.

(i) Calculate the required VT and CT ratios. (2 marks)

(ii) Draw a circuit diagram to show how the meters should be connected to measure the voltage, current and active power for one phase only. (6 marks)

END OF EXAMINATION PAPER