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GOVERNMENT OF MALTA
MINISTRY FOR EDUCATION
AND SPORT

# EXAMINATION FOR AUTHORISATION B

## Paper 1

**Date:** Wednesday 1st July 2026

**Time:** Two hours thirty minutes

**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. The two figures (1 and 2) below show capacitors of value ‘C’ connected in Delta (Figure 1) and Star (Figure 2) configurations.

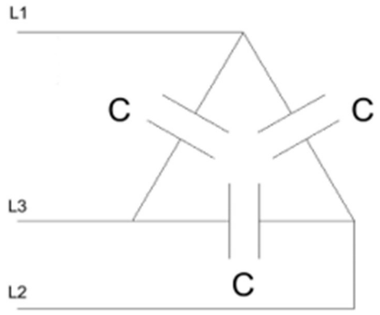



**Figure 1**

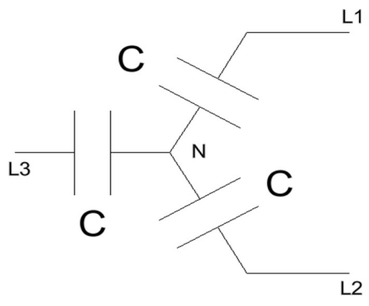



**Figure 2**

(a) For the Delta-connected configuration write an expression for the phase current in terms of C and $V_{Line.}$ (2 marks)

(b) For the Star-connected configuration write an expression for the phase current in terms of C and $V_{Line.}$ (2 marks)

(c) For the Delta-connected configuration write an expression for the total reactive power in kVAr dissipated. (2 marks)

(d) For the Star-connected configuration write an expression for the total reactive power in kVAr dissipated. (2 marks)

(e) A factory supplied by a 400V 50Hz three-phase four wire network connection requires a total of 30 kVAr reactive power to compensate for the low power factor. Calculate the capacitor values, in microfarads, if the system selected is connected in delta-configuration. (2 marks)



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2. A Medium Voltage Delta-Star transformer is rated 300 kVA, 11kV primary (Delta) and 400 V secondary (Star).

   (a) Draw a schematic drawing of the transformer showing the 3 windings and connection terminals. (3 marks)

   (b) Calculate the primary and secondary line and phase currents of the transformer at full load. (4 marks)

   (c) Given that the primary number of turns is 1800 turns, calculate the secondary number of turns. (3 marks)

3. A 400V, three-phase Star-connected generator alternator supplies a Delta-connected induction motor. The motor efficiency and power factor are 87% and 0.8 respectively. The load on the motor mechanical shaft is 14.92 kW.

   Calculate the:

   a) current in each motor winding (4 marks)

   b) current in each alternator winding (2 marks)

   c) power to be developed by the engine driving the generator alternator if the efficiency of the alternator is 82%. (4 marks)

4. A three-phase induction motor is rated 8.5 kW, 400 V, 50 Hz, at 0.9 power factor. The starting current is 6.5 times the full-load current.

   (a) Calculate:

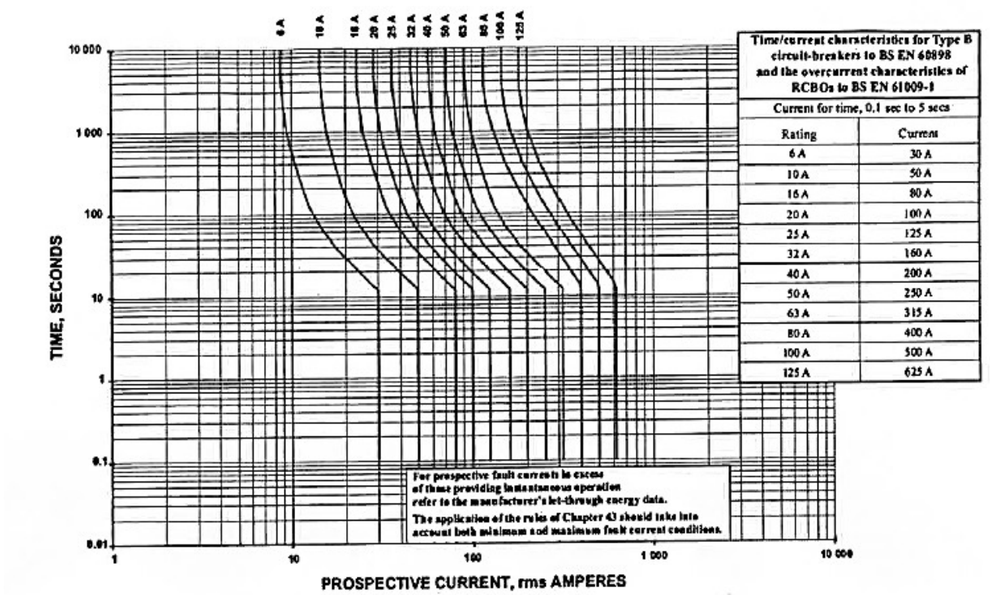
   i) the full-load line current (3 marks)

   ii) the starting current (1 marks)

   iii) a suitable thermal overload relay setting assuming machine full load continuous rating is 1.05 × FLC. (2 marks)

(b) Two MCBs are available: 16 A Type B and 16 A Type C. The characteristics curves for each type are given in Figures 3 and 4 respectively.

Select the most suitable MCB and give a reason for your answer. (4 marks)

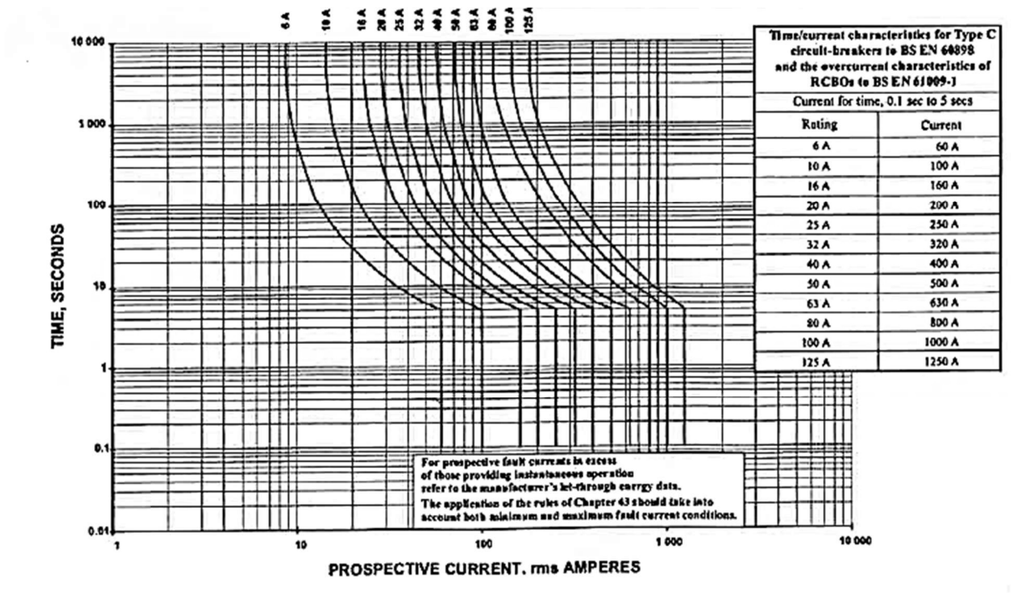



Time/current characteristics for Type B circuit-breakers to BS EN 60898 and the overcurrent characteristics of RCBOs to BS EN 61009-1

Current for time, 0.1 sec to 5 secs

| Rating | Current |
|---|---|
| 6 A | 30 A |
| 10 A | 50 A |
| 16 A | 80 A |
| 20 A | 100 A |
| 25 A | 125 A |
| 32 A | 160 A |
| 40 A | 200 A |
| 50 A | 250 A |
| 63 A | 315 A |
| 80 A | 400 A |
| 100 A | 500 A |
| 125 A | 625 A |

**Figure 3 Type B Circuit Breakers Characteristics**




Time/current characteristics for Type C circuit-breakers to BS EN 60898 and the overcurrent characteristics of RCBOs to BS EN 61009-1

Current for time, 0.1 sec to 5 secs

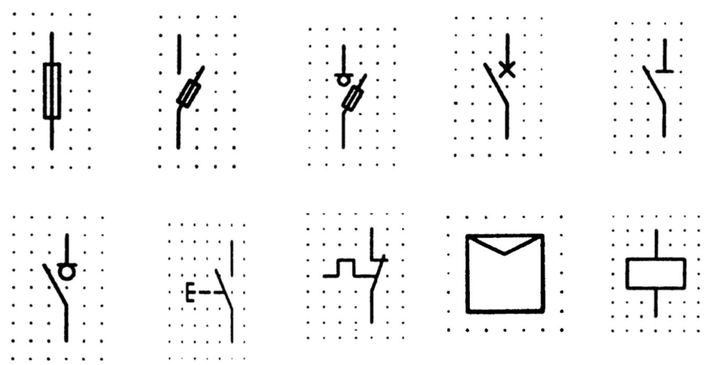
| Rating | Current |
|---|---|
| 6 A | 60 A |
| 10 A | 100 A |
| 16 A | 160 A |
| 20 A | 200 A |
| 25 A | 250 A |
| 32 A | 320 A |
| 40 A | 400 A |
| 50 A | 500 A |
| 63 A | 630 A |
| 80 A | 800 A |
| 100 A | 1000 A |
| 125 A | 1250 A |

**Figure 4 Type C Circuit Breakers Characteristics**



9. **On your booklet** draw each of the TEN symbols shown below and clearly state what each symbol represents. Present your answer in the following table format:

| SYMBOL | NAME |
|---|---|
| | |



(10 marks)

10. IET BS7671:2018 Section 740 covers temporary electrical installations in booths, stands and amusement devices. Answer the following with reference to the general requirements.

(a) State the nominal supply voltage of temporary electrical installations in booths, stands and amusement devices. (2 marks)

(b) State the minimum ingress protection rating required for electrical equipment. (1 mark)

(c) State the maximum rated residual operating current and the type of RCD required for automatic disconnection of supply at the origin of the temporary electrical installation. (2 marks)

(d) State THREE precautions to be taken when using transportable floodlights in order to prevent mechanical damage. (3 marks)

(e) State TWO precautions to be observed when locating the generator. (2 marks)

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5. (a) In the design of electrical installations, it is essential to distinguish between the total connected load and the load likely to be used simultaneously. This distinction is important to ensure safe and economical installation. With reference to connected load, maximum demand and diversity, explain why the distinction is important. (5 marks)

(b) An electrical installation is supplied from an 8-way consumer unit with a 100A main circuit breaker. The consumer unit has two spare ways and supplies the following six single-phase circuits:

- one 10.5 kW cooker circuit with no socket-outlet on the control unit;
- two 32 A ring final circuits;
- one 3 kW immersion heater;
- two lighting circuits: Circuit 1 consists of six tungsten lamps, and Circuit 2 consists of six fluorescent tubes.

Determine the maximum demand, using the diversity factors given in Table 1 below, and state if the rating of the main switch is adequate or otherwise. (5 marks)

**Cooker Circuit:**

allowing for diversity, the first 10 A + 30% of remainder + 5 A allowance for socket outlet.

**Socket-outlet circuits:**

100% of first ring circuit + 40% of second ring circuit.

**Two lighting circuits:**

**Circuit 1**, tungsten lamps, assume 100 W per lamp.

**Circuit 2**, fluorescent lamps, assume 100 W per lamp and multiply the lamp wattage by 1.8.

In addition, 66% of first circuit + 66% of second circuit.

**Immersion heater circuit:**

No diversity allowed.

**Table 1**



7. (a) Draw a clearly labelled schematic diagram of a TT earthing system, showing the:

- two distinct earthing points (source-side and installation-side).
- connection point for the neutral conductor (N) at the source.
- connection point for the protective earth conductor (PE) at the consumer's installation.
- separation between the neutral and protective earth conductors throughout the installation. (5 marks)

(b) (i) Describe the configuration of a TT (Terre-Terre) earthing system. Explain why continuous insulation monitoring is not normally required for this system as against an IT (Isolated-Terre) system. (3 marks)

(ii) State one disadvantage of a TT earthing system. (2 marks)

8. (a) A moving-coil instrument has a resistance of 5Ω and takes 30mA to produce full scale deflection. Calculate the resistor value to be added so that the moving coil instrument is used as

(i) an ammeter reading 0 to 2 A (3 marks)

(ii) a voltmeter reading 0 to 10 V. (3 marks)

(b) (i) Draw a well labelled diagram of a current transformer suitable for use with an ammeter having a full-scale deflection of 2 A. (2 marks)

(ii) Describe the transformer drawn to measure currents flowing in the main AC circuit. (2 marks)

6. A 7.4kW 230V 50Hz single-phase electric vehicle (EV) charger is to be supplied from the main distribution board located 25 metres away. The EV charger will be supplied by an underground Single Wire Armour (SWA) 6.0 $mm^2$ cable buried direct 450mm deep. There are no other cables buried together with the EV charger cable. The ambient temperature is 20°C.

Apply the correction factors given below, as given by BS 7671 standard:

- Installation method (buried direct): Ca = 1.0
- Ambient temp (20°C underground): Cg = 1.0
- Grouping (single circuit): Ci = 1.0

(a) Using the information above and the tabulated data provided in Tables 2 and 3, calculate the design current and verify whether the selected cable size for the single-phase electric vehicle (EV) charger is adequate. (7 marks)

(b) State the measures that must be taken into consideration to ensure that the EV charger is supplied safely. (3 marks)



Ambient temperature: 30 °C
Ground ambient temperature: 20 °C
Conductor operating temperature: 70 °C

CURRENT-CARRYING CAPACITY (amperes):

| Conductor cross-sectional area | Reference Method C (clipped direct) | | Reference Method E (in free air or on a perforated cable tray etc, horizontal or vertical) | | Reference Method D (direct in ground or in ducting in ground, in or around buildings) | |
|---|---|---|---|---|---|---|
| | 1 two-core cable, single-phase AC or DC | 1 three- or four-core cable, three-phase AC | 1 two-core cable, single-phase AC or DC | 1 three- or four-core cable, three-phase AC | 1 two-core cable, single-phase AC or DC | 1 three- or four-core cable, three-phase AC |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| ($mm^2$) | (A) | (A) | (A) | (A) | (A) | (A) |
| 1.5 | 21 | 18 | 22 | 19 | 22 | 18 |
| 2.5 | 28 | 25 | 31 | 26 | 29 | 24 |
| 4 | 38 | 33 | 41 | 35 | 37 | 30 |
| 6 | 49 | 42 | 53 | 45 | 46 | 38 |
| 10 | 67 | 58 | 72 | 62 | 60 | 50 |
| 16 | 89 | 77 | 97 | 83 | 78 | 64 |
| 25 | 118 | 102 | 128 | 110 | 99 | 82 |
| 35 | 145 | 125 | 157 | 135 | 119 | 98 |
| 50 | 175 | 151 | 190 | 163 | 140 | 116 |

**Table 2**

VOLTAGE DROP (per ampere per metre): Conductor operating temperature: 70 °C

| Conductor cross-sectional area | Two-core cable, DC | Two-core cable, single-phase AC | | | Three- or four-core cable, three-phase AC | | |
|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | | | 4 | | |
| ($mm^2$) | (mV/A/m) | (mV/A/m) | | | (mV/A/m) | | |
| 1.5 | 29 | 29 | | | 25 | | |
| 2.5 | 18 | 18 | | | 15 | | |
| 4 | 11 | 11 | | | 9.5 | | |
| 6 | 7.3 | 7.3 | | | 6.4 | | |
| 10 | 4.4 | 4.4 | | | 3.8 | | |
| 16 | 2.8 | 2.8 | | | 2.4 | | |
| | | r | x | z | r | x | z |
| 25 | 1.75 | 1.75 | 0.170 | 1.75 | 1.50 | 0.145 | 1.50 |
| 35 | 1.25 | 1.25 | 0.165 | 1.25 | 1.10 | 0.145 | 1.10 |
| 50 | 0.93 | 0.93 | 0.165 | 0.94 | 0.80 | 0.140 | 0.81 |

**Table 3**