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

EXAMINATION FOR AUTHORISATION B

Paper 1

Date: Tuesday 27th January 2026

Time: 15:30 – 18:00 (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. (a) Authorised persons are exposed to electric shock risk. State briefly **FOUR** actions that can mitigate the risks. (4 marks)

(b) (i) Name the fire extinguisher that is used for electrical fire and give a reason for your answer. (3 marks)

(ii) List the **THREE** precautions that need to be followed when using a portable fire extinguisher. (3 marks)

2. (a) A copper wire has a resistance of 210 Ω at 20 ^{o}C. A current is passed through the wire, and the temperature rises to 90 ^{o}C. The temperature coefficient of resistance at 0^{o}C is 0.004/^{o}C. Determine the resistance of the wire at 90 ^{o}C. (4 marks)

(b) (i) Explain the basic principle of rotation of an Induction Motor. (2 marks)

(ii) Explain **TWO** differences between a Single-Phase Induction Motor and Three-Phase Induction Motor. (4 marks)

3. (a) With the aid of a diagram explain the construction of an autotransformer and how it works. (4 marks)

(b) Give **THREE** advantages and **THREE** disadvantages of an autotransformer. (6 marks)

4. A coil having a resistance 5 Ω and an inductance of 120 mH is connected in series with a 100 μF capacitor. The circuit is connected across a 300 V, 50 Hz supply.

(a) Draw the circuit for the network described above. (1 mark)

Calculate the following:

(b) The current flowing. (3 marks)

(c) The phase angle between the supply voltage and current. (2 marks)

(d) The voltage across the coil. (2 marks)

(e) The voltage across the capacitor. (2 marks)

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

(b) A restaurant is supplied from a three-phase and neutral, 400V, 50Hz system. A three-phase, star connected, pizza oven is connected across the supply and develops a fault to earth causing the earth protection device (RCD) to trip. A data logger is connected across the supply and an instantaneous current of 6 kA flowing in the grey line (L3) to earth is recorded. The external loop impedance is measured as 0.01Ω, while the supply cable impedance to the pizza oven is 0.02Ω. Calculate the earth fault contact impedance inside the pizza oven. (5 marks)

(c) The miniature circuit breaker of the pizza oven, in 'b', is found faulty and must be replaced. What is the recommended current rating and the prospective fault current rating of the miniature circuit breaker if the pizza oven power rating is 12.8 kW (star connected heater elements & assume unity power factor)? (3 marks)

6. (a) The steel workshop manufactures several types of steel structures. It consumes a substantial amount of electricity. The Distribution System Operator kWh energy meter was replaced by a new energy meter measuring the energy in kWh and the Maximum Demand. The line manager requested you to explain the difference between the type of energy meters. Explain briefly the difference between the two types of energy meters and state what is the scope of the maximum demand meter. (5 marks)

(b) The table below shows the three-phase machine loads required to be used during a normal working day. (Assume 400V. unity power factor, 50Hz)

Type of Starter	**Machine**	**Power**
Soft starter	40T Steel press	40kW
Soft starter	Bending machine	30kW
Star/delta starter	Lathe machine	10kW
Star/delta starter	Welding machine	10kW
Star/delta starter	Steel cutting saw	12kW

When starting the machines using a soft starter, the full load current is multiplied by one. When starting the machines using the star/delta starter, the full load current is multiplied by four. The maximum demand meter records 78kW within the 30 minutes recording. Referring to the table above, list the **TWO** machines switched-on during this recording. (Show the working for your answer). (5 marks)

7. A 2kW, 400V, 0.8 p.f, 50Hz, three-phase delta connected equipment is installed in a danger zone room. The equipment is required to be switched on or off remotely.

(a) Draw a circuit diagram to show how you would remotely switch-on or off the direct-on-line starter installed inside the danger zone room. (5 marks)

(b) Indicate the rating of the direct-on-line starter and components used. (5 marks)

8. (a) For each of the following tools used on a construction site, give the recommended voltage level and describe the tool's means of supply?

(i) Portable hand lamps in confined and/or damp locations. (2 marks)

(ii) Portable hand power tools. (2 marks)

(iii) Outdoor fixed flood lighting. (2 marks)

(b) Consider a TT system that provides power to construction areas and horticultural premises. The IET regulation 415.2.2 specifies that the resistance, R, between simultaneous accessible exposed and extraneous conductive parts shall fulfil the following condition $R \leq 50V / I\Delta n$.

where the,

$I\Delta n$ is the actuating or triggering current threshold of a protection RCD and the 50V value is the voltage developed on the exposed surface during a fault.

(i) What is the maximum value of $I\Delta n$ recommended for an RCD protecting against potential contact by humans or livestock? (1 mark)

(ii) Calculate the allowed maximum resistance. (1 mark)

(iii) Explain which elements, in an electrical system, directly influence the recommended resistance value. (2 marks)

9. The MCB's setup in Figure 1 is used for protection in a 3-phase distribution board system. Downstream the main MCB, there is an MCB feeding a 3-phase motor having a full load rating of 16A. The motor is controlled with a star-delta starter to limit the starting current.

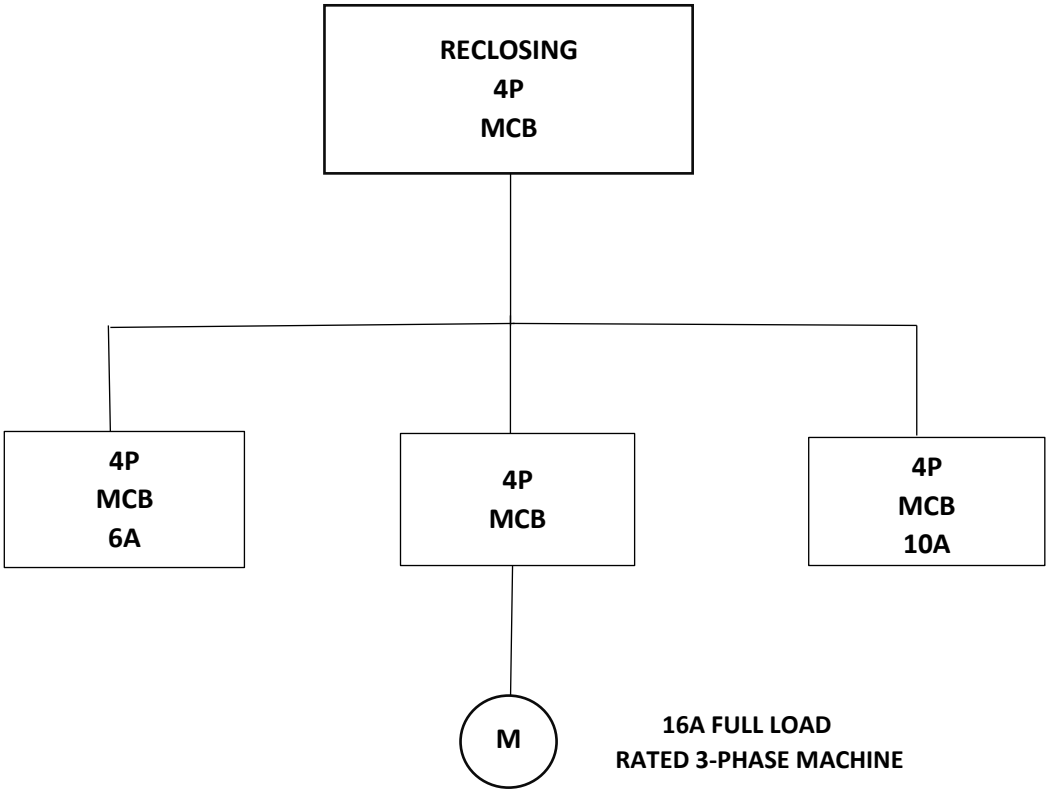

Figure 1 Distribution board MCB layout

(a) Assuming a starting current of 6.5 times the full load current, calculate the:

(i) starting current of this machine if a star-delta starter is not used (1 mark)

(ii) starting current of this machine when the starter is in STAR connection. (1 mark)

(b) The authorised person is to select an MCB which trips by means of a magnetic element when the machine unintentionally or if by a fault starts in DELTA connection for a duration of 10 seconds. Given the characteristics in Figures 2 and 3 for Type B and Type C MCB's respectively, select the correct type of MCB to protect this machine. Justify the selection of the correct MCB type. (3 marks)

(c) For the incoming main MCB the authorised person gave instructions that the magnetic element must be greater than 3 times the calculated starting current in 9(b) of the motor. Take into consideration the maximum load of all units downstream the main MCB.

From the IET Wiring Regulations extract provided on the separate sheet, select the incoming main MCB rating and type to protect the downstream circuits. Justify the selected MCB. (3 marks)

(d) The prospective short circuit current at this point of the distribution system is calculated to be 450 A. If a fault direct short circuit happens on the machine (e.g. star and delta contactors go in simultaneously) how will the system behave? (2 marks)

10. A power transformer is to be tested, and the following equipment in the box will be provided:

- Micro-ohm Tester (Ductor) (instrument that reads very low resistance down to μΩ).
- Dielectric strength tester.
- RLC instrument (an instrument that reads resistance, inductance and capacitance) over a range of frequencies in the range of hundreds to kHz).
- High Voltage insulation tester capable of generating up to medium voltage levels.

(a) Name the instrument suitable to test each of the following:

(i) Main Transformer connection terminals to LV busbars and the busbar link connections. (1 mark)

(ii) Check if transformer withstands the required working voltage for both the primary and secondary windings. (1 mark)

(iii) Possible interturn winding short circuit. (1 mark)

(iv) Oil integrity. (1 mark)

(v) The Star connected winding to the main earth bar. (1 mark)

(b) The BS 7671 classifies various "Special Locations" with intensified risks. These special locations require additional specific electrical safety measures. List **FIVE** special locations examples. (5 marks)

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