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

EXAMINATION FOR AUTHORISATION B

Paper 1

Date: **Wednesday 2nd July 2025**

Time: **09:00 – 11:30 (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) Define the temperature coefficient for the resistance of an electrical conducting material. (2 marks)

   (b) Mention one electrical conducting material with a negative temperature coefficient. (1 mark)

   (c) A three-phase direct-on line starter contactor coil has a resistance of 250Ω at 15°C. The starter is installed outdoor and is subjected to direct sunlight. The measured outdoor temperature is 42°C. Calculate the contactor coil resistance at 42°C.

   Assume that the coil winding wire is copper with a temperature coefficient of 0.004Ω/Ω °C. (7 marks)

2. A 25nF capacitor is connected in parallel with a coil of resistance 12 kΩ and inductance 0.4 H. The circuit is connected to a 12V, 4kHz supply.

   Determine the:

   (i) current in the coil (3 marks)
   (ii) current in the capacitor (3 marks)
   (iii) supply current. (4 marks)

3. A three-phase balanced load consists of three similar inductive coils, each of the resistance 50Ω and inductance 0.6H. The supply is 400V, 50Hz.

   Calculate the following:

   (i) line current when the load is star connected (3 marks)
   (ii) total power when the load is star connected (2 marks)
   (iii) line current when the load is Delta connected (3 marks)
   (iv) total power when the load is Delta connected. (2 marks)

4. A steel metal workshop consists of the following two loads (A and B):
   A. Heavy duty cutting machine of an efficiency of 80% and power output of 24kW at power factor of 0.8 lagging
   B. Socket-outlets and lighting circuits rated power of 12kW at unity power factor but only 50% of the rated power is used.

   The above loads (A and B) are balanced over the three-phase 400V supply and connected across a three-phase capacitor bank of 22.5kVAR (reactive).

   Determine the:

   (i) total power in kW (6 marks)
   (ii) total reactive power. (4 marks)

5. A small hotel supplied at 400/230V 50Hz has the following connected load:

100 in quantity 100W lighting points
50 x 13A socket outlets on 6 x 32 A ring circuits
30 x 1kW (single phase) convection heaters
16kW 3-phase connected central water heating boiler
Cooking equipment: 2 x 14kW cookers, 3 x 2kW fryers and 1 x 4kW hot storage cupboard. All loads on single-phase.

(a) Using Table 1 provided below calculate the assumed maximum demand for

i) lighting circuits (1 marks)
ii) socket outlets (1 marks)
iii) heating equipment (3 marks)
iv) cooking equipment. (2 marks)

(b) Calculate the total maximum demand for the hotel distributing the single-phase load equally on the 3-phase supply. (3 marks)

Allowances for diversity		
Purpose of final circuit fed from conductors or switchgear to which diversity applies	Type of premises	
	Individual household installations including individual dwellings of a block	Small hotels, boarding houses, guest houses, etc
1. Lighting	66% of total current demand	75% of total current demand
2. Heating and power	100% of total current demand up to 10 amperes +50% of any current demand in excess of 10 amperes	100% f.l. of largest appliance +80% f.l. of second largest appliance +60% f.l. of remaining appliances
3. Cooking appliances	10 amperes +30% f.l. of connected cooking appliances in excess of 10 amperes +5 amperes if socket-outlet incorporated in control unit	100% f.l. of largest appliance +80% f.l. of second largest appliance +60% f.l. of remaining appliances
4. Standard arrangement of final circuits using socket-outlets	100% of current demand of largest circuit +40% of current demand of every other circuit	100% of current demand of largest circuit +50% of current demand of every other circuit

Table 1

6. A 400V 50Hz three phase extractor fan motor has a rating of 15Kw at 0.8 pf lagging and is supplied from a BS 88 Part 2 distribution board equipped with BS 88 fuses. The distance from the DB to the starter is approximately 40m. The cables are single cores (thermoplastic) pvc insulated run in steel trunking with three other similar circuits. Assuming an ambient temperature of 35 ºC.

   (a) Calculate the full load rating of the motor. (2 marks)

   (b) State the rating of the BS88 fuse to be used. (2 marks)

   (c) Using the appropriate factors from the tables 2A and 2B provided below, determine the minimum current rating of the cable. (4 marks)

   (d) Use the information in Table 3A to choose the minimum cross-sectional area of the cable. (2 marks)

Correction factors for ambient temperatures where protection is against short-circuit and overload							
Type of insulation	Operating temperature	Ambient temperature ^{0}C					
		25	30	35	40	45	50
Thermoplastic (general purpose pvc)	70^{0}C	1.03	1.0	0.94	0.87	0.79	0.71

Table 2A

Correction factor for groups of more than one circuit of single core cables ,or more than one multicore cable						
Enclosed in conduit or bunched and clipped direct to non metalic surface	Enclosed in conduit or bunched and clipped direct to non metalic surface					
	2	3	4	5	6	7
	0.8	0.7	0.65	0.6	0.57	0.54

Table 2B

Current carrying capacity of copper conductors of Pvc insulated non armoured single core cables		
Conductor cross sectional area	Reference method 3 &4 (enclosed in conduit on a wall or in trunking in or in a wall)	
mm^2	2 cables single-phase a.c. or d.c.	3 or 4 cables three phase a.c
1	13.5 A	12 A
1.5	17.5A	15.5A
2.5	24A	21A
4	32A	28A
6	41A	36A
10	57A	50A
16	76A	68A
25	101A	89A
35	125A	110A

Table 3A

7. The following table lists different types of wiring systems.

Type of Wiring Systems
PVC conduit
Galvanised Metal trunking
Galvanised Metal Cable trays
Plastic trunking
Busbar trunking
Non armoured cables
Armoured cable laid in a layer of soft sand covered with limestone slabs

a) For each case study below, name the most appropriate type of wiring system. (6 marks)

Case Study A:	Multiple office buildings which may include Cat 5 cable layout and potential future relocations of desks.
Case Study B:	Underground cable runlaid in trench 1m deep.
Case Study C:	Factory which has many machines requiring power and control cables.

b) What is represented by the prefix term IP XY assigned to enclosures? (2 marks)

c) What is represented by X? (1 mark)

d) What is represented by Y? (1 mark)

8. (a) The BS 7671 refers to special locations. Describe what is meant by Special Locations. (3 marks)

(b) List any five classifications which are included in the BS 7671. (5 marks)

(c) BS 7671 provides guidelines on how to relieve the risk of electric shock in special locations. Specify how this could be achieved. (2 marks)

9. The range of electrical measuring instruments is limited by the rated current of the coils used in the measuring instruments.

(a) List four common devices that are used to extend the range of Ammeters, Voltmeters or any other type of measuring instrument. (4 marks)

(b) Describe how the range of an ammeter can be extended. (2 marks)

(c) Describe how the range of a voltmeter can be extended. (2 marks)

(d) For each of the devices used for extending the range of the instruments in both *(b) and (c)* above, state at least one property required. (2 marks)

10. (a)(i) Describe a three-phase energy meter.

(ii) How does a three-phase energy meter differ from a single-phase meter? (4 marks)

(b) List two advantages and two disadvantages of using a three-phase energy meter.(4 marks)

(c) List two types of buildings or applications that are best suited for three-phase energy meters. (2 marks)

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