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

EXAMINATION FOR AUTHORISATION A

Paper 2

Date: 7th February 2024

Time: 9:00 – 12:00 (Three hours)

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.

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

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 farmhouse requires the laying of a 4-core PVC sheathed armoured cables. The insulation resistance of each cable is measured before it is installed. The insulation resistance reading for 500m is 1000 Mega Ohms. Calculate the estimated insulation resistance reading you would expect from each of the following lengths:

i. 50m length of cable **(2 marks)**

ii. 100m length of cable **(2 marks)**

iii. 200m length of cable **(2 marks)**

iv. 300m length of cable **(2 marks)**

v. 600m length of cable. **(2 marks)**

(b) For the calculations in part (a) tabulate the results in a table. **(5marks)**

(c) Draw a graph showing the relationship between the cable length against the insulation resistance. **(5 marks)**

2.(a) Briefly explain the difference between non-metal and metal material found in several electrical installations and give three examples of each. **(6 marks)**

(b) i. What is the difference between ferrous and non-ferrous material? **(2 marks)**
ii. Give two examples of each. **(2 marks)**

(c) State one advantage and one disadvantage for each of the following:
i. Metal Conduit.
ii. Plastic Conduit. **(4 marks)**

(d) You are required to terminate a single core copper conductor cable with a single core aluminium conductor cable.
i. Draw a connection ferrule used to join the two conductors. **(2 marks)**
ii. Briefly explain the reaction between copper and aluminium conductors if a proper connector is not used. **(4 marks)**

3.(a) A small shop within a shopping mall is to be supplied from a 230V 50Hz supply. The total calculated load for this shop is 6 kW and the power factor is assumed to be 0.85 lagging. The cable supplying this shop is to be protected by a BS 88 Part 2 fuse.
The measured distance from the nearest distribution board to the shop is 60m. The cables which will be used to supply the workshop are to be single core cables, PVC insulated, installed in steel trunking with three similar circuits. Assume an ambient temperature of 35ºC and that the voltage drop in the cables is limited to 2.5%.
Using the tables 3.1 to 3.4 and ignoring any diversity, calculate:

i. The full load current required for the workshop (I_b) **(2 marks)**

ii. The rating of the fuse (I_n) **(2 marks)**

iii. The minimum current rating of the cables **(6 marks)**

iv. The minimum cross-sectional area of the cables **(6 marks)**

v. The actual voltage drop in the cables. **(4 marks)**

Tables 3.1 to 3.4:

Table 3.1	Fuse Rating to BS 88 Part 2				
6A	10A	16A	20A	32A	50A

Table 3.2	Grouping Factor						
No of Circuits	1	2	3	4	5	6	7
C_g	1.0	0.8	0.7	0.65	0.6	0.57	0.54

Table 3.3 single-core PVC cable								
Ambient temperature (^{0}C)	25	30	35	40	45	50	55	60
C_a	1.03	1.0	0.94	0.87	0.79	0.71	0.61	0.50

Table 3.4 Single core 70^{0}C PVC copper cables – Method B		
Cross Sectional Area mm^2	Current carrying capacity (A)	Voltage drop mV/A/m
1	13.5	38
1.5	17.5	25
2.5	24	15
4	32	9.5
6	41	6.4
10	57	3.8
16	76	2.4

4.(a) With the aid of a diagram explain what is meant by the term "**Discrimination**". Explain how effective discrimination is achieved in an electrical installation. **(5 marks)**

(b) Describe the term **diversity factor** and state its importance. **(5 marks)**

(c) A bakery shop is supplied from a single phase 230V 50Hz supply. The load connected to the installation comprises of the following items:

- 15 lighting filament lamps at 100W each
- 10 twin 13Amp socket outlets (2 ring circuits)
- A 8kW cooker controlled from a cooker unit combined with a 13A socket outlet.

i. Calculate the assumed current demand for the installation by applying the diversity factor as provided in the table below. **(10 marks)**

Table 4.1:

Purpose of the final circuit	Diversity to be applied
Lighting	*90% of the total current demand*
Cooking appliance	10 amperes + 30% full load of the connected cooking appliance in excess of 10 amperes + 5 amperes if a socket outlet is incorporated
Heating and Power	100% of total current demand up to 10 amperes + 50% of any current demand in excess of 10 amperes.

5. A summer residence by the seaside has been re-wired in flat twin and earth 70°C cable. All the cables are connected within the building fabric where possible. The house has a supply system of 230V single phase TT system and equipped with a double pole main switch and a 30mA RCD. The earth fault loop impedance needs to be tested to confirm the suitability of the consumer earth electrode.

With reference to the above information, answer the following:

(a) Name the test instrument to be used to carry out the test. **(2 marks)**
(b) Describe how the test should be carried out. **(6 marks)**
(c) What is the maximum earth fault loop impedance value permitted for this installation? Show all calculations. **(3 marks)**
(d) What is the value of electrode resistance above which the value of the electrode resistance could be considered unstable? **(3 marks)**
(e) Which other method could be used to test the resistance of the earth electrode? **(2 marks)**
(f) Which instrument is to be used for the test in 'e'? **(2 marks)**
(g) How many additional electrodes are required? **(2 marks)**

6.(a) A domestic installation is connected to a TT supply system. State the correct sequence of tests to be carried out for the NEW domestic installation. **(12 marks)**

(b) List the correct instruments required to carry out the tests listed in (a) above. **(8 marks)**

END OF EXAMINATION PAPER