Alexandria University
Faculty of Engineering
Electrical Engineering Department
June 2023

جامعة الإسكندرية
كلية الهندسة
قسم الهندسة الكهربية
يونيو 2023

EEP 322
Third year (Power Section)
Time Allowed: 2 Hour (2 parts)

اقتصاديات الطاقة و السلامة الكهربية
السنة الثالثة قوى كهربية
الزمن : ساعتين للجزئين

Part 1

Question One:

It is required to design the electrical network of a hospital. The hospital has 1 floor (Ground Floor). Breaker Ratings available are single phase breakers rated 16, 20, 25, 32, 40 A and three phase breakers rated 20, 25, 32, 40, 50, 60, 80, 100, 125, 160, 250, 400, 630, 800, 1000, 1250, 1600, 2000, 3200A. The load data of each panel is given below. For each load specify the breaker rating and appropriate cable size. Use cable tables provided in the exam. Show the rating of the incoming breaker of the panel and cable size.

It is required to do the following:

1. Design and draw the single line diagram of the following electrical panels complete with ratings of the incoming and the outgoing circuit breakers of all panels, and the suitable incoming and outgoing cable size. Cables are all copper cables.

1.1. Ground Floor Questions

The ground floor is divided in two parts. Part 1 is the operation theater and part 2 is the intensive care unit. Each part ha[illegible] number of its sockets on a UPS. Please answer the following questions:

1.1.1. **Ground Floor - Panel 1** is for the lighting loads of the floor. There are 45 circuits. Each circuit is 0.8 KVA, 220 V. Demand factor is 0.85 for Panel 1. Show proper spare in breakers and in space. The incoming cable of this panel is laid in duct.

1.1.2. **Ground Floor - Panel 2** is for the operation theater Sockets. The operation theater has UPS to feed sockets. The UPS panel is directly fed from the main panel of the building. UPS feeds 15 sockets each socket is loaded is 1.25 kVA,220V. Demand factor is 1. Design a suitable UPS for the loads. Available UPS is 10,15,20,30 kVA. Draw second floor panel 2. Incoming cable is laid in duct.

1.1.3. **Ground Floor - Panel 3** is for the Intensive Care unit. The Intensive care unit has UPS to feed sockets. The UPS panel is directly fed from the main panel of the building. UPS feeds 50 sockets each socket is loaded 0.5 kVA, 220V. Demand Factor is 1. Design a suitable UPS for the loads. Available UPS is 10,15,20,30 kVA. Draw second floor panel 3. Incoming Cable is laid in duct.

1.1.4. **Ground Floor - Panel 4** feeds the following loads:

- 3 circuits, each has a heater of 2 kVA, 220 V single phase.
- 2 instant heaters each is 16 KVA, 3 phase.
- 4 hand dryers each of 2 KVA, 220 v single phase

- 24 circuits, each circuit is feeding a number of sockets with a load for each circuit of 1.25 KVA, 220 V single phase.

Draw the single line diagram for panel 4 indicating all data required for the incoming and outgoing breakers and cables and spare breakers. Demand factor in Panel 4 is 0.8. Main breaker cable of this panel is laid in free air.

1.1.5. **Ground Floor - Panel 5** is for air conditioning units. Panel 5 feeds 30 air-conditioning units (circuits). 20 circuits are rated 4 kVA, 220V and 10 circuits are rated 3 KVA. Panel 5 demand factor is 0.7. Main breaker cable of this panel is laid in duct.

2. Draw the single line diagram of the main switchboard feeding the hospital above with all the required breaker and cable information. The diversity factor between the panels is 1.2. Main breaker cable/cables is laid direct in ground. The cables are aluminum steel tape armored cables. No derating factor is required cables are laid apart from each other.
3. Design the earthing system for the hospital. Draw the earth bars and its connection to the main panel. Also, the connection from the main panel to each panel, show the cross section of all cables used.

Question Two:

The provided layout pertains to the electrical design of a public park. The park consists of a main medium voltage 11 kV switchgear that is supplied power from two different utility sources. The main medium voltage switchgear distributes electricity to eight service transformers through three loop connections. The loads on the main medium voltage switchgear are as follows:

Loop 1 feeds the following loads:

1. Dry type transformer (01): 0.5 MVA, Loading = 82%
2. Dry type transformer (05): 1.6 MVA, Loading = 75%
3. Dry type transformer (06): 0.5 MVA, Loading = 70%

Loop 2 feeds the following loads:

1. Dry type transformer (02): 0.8 MVA, Loading = 85%
2. Dry type transformer (04): 0.8MVA, Loading = 83%
3. Dry type transformer (03): 1.6MVA, Loading = 80%

Loop 3 feeds the following loads:

1. 5-Star hotel, dry type transformer (07): 2MVA, Loading = 87%
2. 4-Star hotel, dry type transformer (08): 1.6MVA, Loading = 85%

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It is required to do the following:

1. Design the single-line diagram of the main medium voltage switchgear for the park. Show in your drawing the ratings of incoming, coupler and outgoing circuit breakers of the switchgear. Also, include the connected load of the loops. Also, indicate the connected load and maximum demand of the medium voltage switchgear, considering a diversity factor of 1.2. Available rating of circuit breakers are 630A – 1250A – 2000A.

2. The medium voltage cables used in the design are 240 mm^2 AL/XLPE/STA/PVC. On the park layout provided, the path of medium voltage cables is indicated by a single bold line. **Note that:** The bold line shows only the path of the medium voltage cables, NOT their number. Complete the following:
   a. Draw a section of the trench for medium voltage cables originating from the distribution room (Section A-A). Specify the trench's width, depth, duct size (if needed), and filling material.
   b. Draw a section of the trench for medium voltage cables (Section B-B). Specify the trench's width, depth, duct size (if required), and filling material.
   c. Draw a section of the street crossing for medium voltage cables (Section C-C). Specify the street crossing's width, depth, duct size (if necessary), and filling material.

Best of Luck
Ashraf Megahed

0.6/1 (1.2) KV *Multi Core Unarmoured Cables*

Multicore Cables, with Stranded Copper Conductors, PVC Insulated and PVC Sheathed

Product Code	Nominal Cross sectional area	Maximum Conductor Resistance		Current Rating			Approx. Overall Diameter	Approx. Overall Diameter
		DC at 20 °C	AC at 70 °C	Laid in ground	Laid in duct	Laid in free air (Shaded)		
	mm²	Ω/Km	Ω/Km	A	A	A	mm	Kg/Km
				4 core cables - Cu/PVC/PVC				
CP1-T104-U04	1.5 RM	12.1	14.6	28	22	21	10.8	180
CP1-T104-U06	2.5 RM	7.41	8.87	36	28	25	11.9	235
CP1-T104-U08	4 RM	4.61	5.54	46	36	36	14	343
CP1-T104-U09	6 RM	3.08	3.69	60	44	45	15.6	454
CP1-T104-U10	10 RM	1.83	2.19	79	58	61	17	610
CP1-T104-U11	16 RM	1.15	1.39	99	73	83	19.6	880
CP1-T104-U12	25 RM	0.727	0.8702	131	96	105	23.5	1270
CP1-T104-U13	35 RM	0.524	0.6274	158	116	129	26.2	1660
				4 core cables with reduced neutral - Cu/PVC/PVC				
CP1-T105-U14	50SM / 25 RM	0.387 / 0.727	0.4635 / 0.8702	195	141	161	28.3	1920
CP1-T105-U15	70SM / 35 RM	0.268 / 0.524	0.3214 / 0.6274	239	175	203	31.9	2680
CP1-T105-U16	95SM / 50SM	0.193 / 0.387	0.2319 / 0.4635	282	209	243	34.3	3640
CP1-T105-U17	120SM / 70SM	0.153 / 0.268	0.1844 / 0.6214	322	241	282	37.7	4575
CP1-T105-U18	150SM / 70SM	0.124 / 0.268	0.15 / 0.6214	361	273	323	41.5	5440
CP1-T105-U19	185SM / 95SM	0.0991 / 0.193	0.1206 / 0.2319	407	311	372	46.4	6910
CP1-T105-U20	240SM / 120SM	0.0754 / 0.153	0.0928 / 0.1844	472	366	441	52.4	8905
CP1-T105-U30	300SM / 150SM	0.0601 / 0.124	0.0752 / 0.15	532	419	507	58.2	11105

0.6/1 (1.2) KV **Multi Core STA cables**

Multicore Cables, with Stranded Aluminium Conductors, PVC Insulated, Steel Tape Armoured and PVC Sheatheded

Product Code	Nominal Cross sectional area	Maximum Conductor Resistance		Current Rating			Approx. Overall Diameter	Approx. Overall Diameter
		DC at 20 °C	AC at 70 °C	Laid in ground	Laid in duct	Laid in free air (Shaded)		
	mm²	Ω/Km	Ω/Km	A	A	A	mm	Kg/Km
				4 core cables - AL/PVC/STA/PVC				
AP1-T104-G11	16 RM	1.91	2.295	78	57	62	22.1	670
AP1-T104-G12	25 RM	1.2	1.442	101	75	82	25.7	910
AP1-T104-G13	35 RM	0.868	1.0432	121	91	100	28.4	1105
				4 core cables with reduced neutral - AL/PVC/STA/PVC				
AP1-T105-G14	50SM / 25RM	0.641 / 1.2	0.7704 / 1.442	149	111	125	30.5	1240
AP1-T105-G15	70SM / 35RM	0.443 / 0.868	0.5327 / 1.0432	183	137	158	34.5	1600
AP1-T105-G16	95SM / 50SM	0.32 / 0.641	0.3851 / 0.7704	232	171	205	38.1	2315
AP1-T105-G17	120SM / 70SM	0.253 / 0.443	0.3048 / 0.5327	265	197	239	41.7	2750
AP1-T105-G18	150SM / 70SM	0.206 / 0.443	0.2485 / 0.5327	297	223	273	45.7	3245
AP1-T105-G19	185SM / 95SM	0.164 / 0.32	0.1983 / 0.3851	338	257	318	50.4	3860
AP1-T105-G20	240SM / 120SM	0.125 / 0.253	0.1518 / 0.3048	393	302	379	56.4	4790
AP1-T105-G30	300SM / 150SM	0.1 / 0.206	0.1222 / 0.2485	445	346	439	62.2	5795
AP1-T105-G40	400SM / 185SM	0.0778 / 0.164	0.0961 / 0.1983	511	404	517	70.3	7375
AP1-T105-G50	500SM / 240SM	0.0605 / 0.125	0.076 / 0.1518	585	468	607	78.9	9775


Transformer (06)
0.5MVA
Transformer (03)
1.6MVA
Transformer (04)
0.8MVA
Transformer (05)
1.6MVA
Transformer (02)
0.8MVA
Hotel 4-stars
Transformer(08)
1.6MVA
Hotel 5-stars
Transformer(07)
2MVA
B
B
Transformer (01)
0.5MVA
Main MVSWG
A
A