



SCHOOL OF ELECTRICAL AND ELECTRONIC ENGINEERING

CERTIFICATE IV IN ELECTRICAL ENGINEERING

EEE445- ELECTRICAL INSTALLATION TECHNOLOGY B

FINAL EXAMINATION PAPER PENSTER 4– 2017

Day/Date: TBA

Time: TBA

Room: TBA

Duration of Exam: 2hrs: 10mins

Total No. of Pages: 8Pages including Tables

Total Marks: 100 marks

INSTRUCTIONS TO STUDENTS:

1. You are allowed 10 minutes extra reading time during which you are NOT allowed to write.
2. Begin each SECTION on a fresh page and use both sides of the sheet.
3. Write your candidate number at the top of each answer sheet.
4. Insert all foolscaps, graph paper, drawing paper etc. in their correct sequence and secure with string.
5. For all sheets of paper on which rough / draft work has been done, cross it through and you must attach to the answer booklet.
6. Write clearly the number(s) of the question(s) attempted on top of each sheet.
7. Show all workings where necessary.
8. Tables are attached at the end of the question paper; you are allowed to remove them at your discretion.
9. ATTEMPT ALL QUESTIONS

In each of the following statements, one of the suggested answer is the best one. Write the identifying letter of the answer beside the question number on your answer sheet.

1. The major part of the electricity supply and distribution system is by:
 - a. Bare aerial conductors.
 - b. Insulated conductors.
 - c. Underground cables.
 - d. Enclosed aerial conductors.

2. An enclosure for housing and protecting electrical cables and conductors is known as:
 - a. Busway system
 - b. Catenary support
 - c. Enclosed cable
 - d. Cable Duct.

3. A closed passage formed underground or in a structure into which cables are drawn is known as:
 - a. Catenary
 - b. Cable trunking
 - c. Busway
 - d. Cable duct

4. The most common type of fitting designed by the manufacturers to be used in the installation of MIMS cables is the:
 - a. Insulating tape
 - b. Multimeter
 - c. Screwdriver
 - d. Cable gland

5. The wiring system confined to low and extra low voltage lighting application is:
 - a. Open wiring
 - b. Track systems
 - c. Undercarpet wiring
 - d. Trunking

6. The value of the neutral current in any three phase wiring system is:
 - a. Phasor sum of the line current
 - b. Sum of the phase currents
 - c. Minus the phasor sum of the line currents
 - d. All of the above

7. Apart from being double insulated the cable used for catenary support system should be:
 - a. Copper
 - b. Solid
 - c. Stranded
 - d. Aluminum

8. One of the places where under-floor trunking system is best supplied is the:
 - a. Under-carpet
 - b. Underground
 - c. Under supermarket counter
 - d. Under workshop machines

9. The best type of cable to be used in boiler or engine rooms is:
- TPS cable
 - PVC cable
 - Steel cable
 - MIMS cable
10. The most preferred wiring system in densely populated areas for distribution would be:
- Opening wiring
 - Trunking
 - Underground
 - Cable ducts

SECTION B**(25 MARKS)**

1. There are nine factors to consider while arranging an electrical installation into circuits, name at least four of them. (4marks)
2. Name and explain in your own words the four ways to finding maximum demand. (2marks)
3. Briefly explain on what is renewable energy. (3marks)
4. Why don't we use renewable energy all the time? (3marks)
5. Explain how solar panels produce electric current. (2marks)
6. With aid of diagrams, state the principle of operation of the Hydro-Electric Plant. (5marks)
7. Briefly explain the operating principle of wind power generation system. (4marks)
8. Explain what is meant by the "Current-carrying capacity" of the cable. (2marks)

SECTION C**(20 MARKS)**

1. Which wiring system is best suited for densely populated areas? (1 Marks)
2. Explain the Busway system of wiring. (2 Marks)
3. Outline the Track wiring system. (2 Marks)
4. What is trunking system of wiring? (2 Marks)
5. What are the two major types of hydro turbines, under which other types of fall in? (2 Marks)
6. Give two advantages of Geothermal Energy. (2 Marks)
7. Name four types of wind turbines. (4 Marks)
8. Outline five advantages of three phase system. (5 Marks)

SECTION D**(35 MARKS)**


1. Determine the number of GPOs that may be connected to a 240V final subcircuit consisting of 2.5mm² copper cable run in unenclosed in air condition protected by a circuit breaker in a domestic installation in which there are two equally loaded circuit supplying only GPOs, the following is the loading excluding GPOs:
 - 1 × permanently connected room heater = 2400W
 - 1 × permanently connected 40 W fan = 40W
 - 1 × socket-outlet provided for fixed 120 W fan incorporated in a slow combustion room heater = 120W
 - 2 permanently connected 60 W alarm systems = 120W
 - 6 lighting points at 60 W each = 360W (10marks)

2. For a 3 phase 415V is supply, determine the maximum demand for:
 - a) A multiple domestic installation and, where the contribution of each load group are dependent on the number of units per phase. (10marks)
 - b) The submains for each phase. (10marks)The details of the installation are as follows:
A block of units includes:
 - 2 three-bedroom units
 - 8 two-bedroom units
 - 6 one-bedroom units.Each unit is connected to a single-phase supply and fed by submains from tile main switchboard. The individual unit loads are:
 - Three-bedroom unit
 - 16 lights
 - 18 socket-outlets in unit; 1 socket -outlet in common laundry
 - 8 kW range
 - 4.8 kW continues water heater
 - Two-bedroom unit
 - 14 lights
 - 14 socket-outlets in unit; 1 socket-outlet in common laundry
 - 8 kW range
 - 4.8 kW continuous water heater
 - One-bedroom unit
 - 13 lights
 - 12 socket-outlets in unit; 1 socket-outlet in common laundry
 - 7 kW range
 - 3.6 kW continuous water heater
 - Community services
 - 9 socket -outlets
 - 10 lights: 6 x 75 W. 4 x 150 W outside lights.

3. A three phase 11kV star connected system has three identical loads of 100Ω connected to it, calculate the:
 - a) Line Voltage
 - b) Phase Voltage
 - c) Phase Current
 - d) Line Current
 - e) Power in the system. (5marks)

THE END

TABLE C5
SIMPLIFIED PROTECTIVE DEVICE SELECTION FOR CABLES FROM
1 mm² TO 25 mm² USED IN SINGLE-PHASE APPLICATIONS

Cable type: Two-core and earth, flat cable to AS/NZS 5000.2					
Cable cross-sectional area (mm ²)	Protective device rating (<i>I_n</i>)				
	(A)				
	Unenclosed			Enclosed	
	In air	In thermal insulation partially surrounded	In thermal insulation completely surrounded	In air	In ground (See Note 3)
1	16	10	8	13	16
1.5	20	16	10	16	20
2.5	25	20	16	20	32
4	32	25	20	25	40
6	40	32	25	32	50
10	63	50	32	50	63
16	80	63	40	63	80
25	100	80	50	80	100

NOTES TO TABLES C5 AND C6

- 1 Protective device ratings (*I_n*) have been assigned to align with typical current-carrying capacity (*I_c*) figures for flat and circular cables in AS/NZS 3008.1.1 for Australian conditions. The same ratings can be conservatively applied to New Zealand conditions.
- 2 Single-circuit installation methods have been provided to keep the table simple. Derating factors for groups of cables are not addressed, as it is presumed that circuits will—
 - (a) be separated from each other; and
 - (b) operate below maximum current in lower ambient temperature; or
 - (c) for cables assigned normal ratings of 75°C, any increased temperature effects from grouping will not raise cable temperature above 90°C.
- 3 Other cables and installation methods can be sourced from AS/NZS 3008.1, or conservatively compared with the tabulated figures, e.g. cables buried direct in the ground or in walls can be treated as enclosed underground.

TABLE C8
GUIDANCE ON THE LOADING OF POINTS PER FINAL SUBCIRCUIT

Cable cross-sectional area ^a (mm ²)	Rating of circuit-breaker ^a (A)	Contribution of each point (A) (sum must not exceed rating of circuit-breaker)					Maximum connected load for a range ^{aa} (W)	
		Lighting points ^a	10 A single or multiphase socket-outlets ^{ab}		15 A single or multiphase socket-outlets ^{ab}	20 A single or multiphase socket-outlets ^{ab}		Permanently connected fixed or stationary appliances ^a or water heaters
			Non-domestic installations without permanent airconditioning	All domestic installations and non-domestic installations with permanent airconditioning				
1	6	0.5	NP	NP	NP	NP	NP	
1	8	0.5	NP	NP	NP	NP	NP	
1	10	0.5	NP	NP	NP	NP	NP	
1	11	0.5	NP	NP	NP	NP	NP	
1	16	0.5	NP	NP	NP	NP	NP	
1.5	8	0.5	NP	NP	NP	NP	NP	
1.5	10	0.5	NP	NP	NP	NP	NP	
1.5	12	0.5	NP	NP	NP	NP	NP	
1.5	16	0.5	NP	NP	NP	NP	5000	
1.5	20	0.5	NP	NP	NP	NP	5000	
2.5	10	0.5	NP	NP	NP	NP	NP	
2.5	13	0.5	2	1	NP	NP	NP	
2.5	16	0.5	2	1	16	NP	5000	
2.5	20	0.5	2	1	12	20	8000	

(continued)

TABLE C8 (continued)

Cable cross-sectional area ^a (mm ²)	Rating of circuit-breaker ^a (A)	Contribution of each point (A) (sum must not exceed rating of circuit-breaker)					Maximum connected load for a range ^{aa} (W)	
		Lighting points ^a	10 A single or multiphase socket-outlets ^{ab}		15 A single or multiphase socket-outlets ^{ab}	20 A single or multiphase socket-outlets ^{ab}		Permanently connected fixed or stationary appliances ^a or water heaters
			Non-domestic installations without permanent airconditioning	All domestic installations and non-domestic installations with permanent airconditioning				
2.5	25	0.5	2	1	10	18	8000	
2.5	32	0.5	2	1	8	16	10000	
4	16	0.5	2	1	15	NP	5000	
4	20	0.5	2	1	12	20	8000	
4	25	0.5	2	1	10	18	10000	
4	32	0.5	2	1	8	16	10000	
6 ^a	25	0.5	2	1	12	20	15000	
6 ^a	30	0.5	2	1	10	18	10000	
6 ^a	32	0.5	2	1	8	16	13000	
10 ^a	32	0.5	2	1	8	16	13000	
10 ^a	40	0.5	2	1	8	16	>13000	

NP: Denotes socket-outlets not permitted on these circuits

**TABLE C1
MAXIMUM DEMAND—SINGLE AND MULTIPLE DOMESTIC ELECTRICAL INSTALLATIONS**

1 Load group	2 Single domestic electrical installation or individual living unit per phase ^a	3 Blocks of living units ^{a, b, c}		
		4 2 to 5 living units per phase	5 6 to 20 living units per phase	6 21 or more living units per phase
		Loading associated with individual units		
A. Lighting				
(1) Except (n) and load group H below ^{d, e, f}	3 A for 1 to 20 points + 2 A for each additional 20 points or part thereof	6 A	5 A + 0.25 A per living unit	0.5 A per living unit
(n) Outdoor lighting exceeding a total of 1000 W	75% connected load	No assessment for the purpose of maximum demand		
B				
(1) Socket-outlets not exceeding 10A ^{g, h} Permanently connected electrical equipment not exceeding 10 A and not included in other load groups ⁱ	10 A for 1 to 20 points + 5 A for each additional 20 points or part thereof	10 A + 5 A per living unit	15 A + 3.75 A per living unit	50 A + 1.5 A per living unit
(2) Where the electrical installation includes one or more 15 A socket-outlets, other than socket-outlets provided to supply electrical equipment set out in groups C, D, E, F, G, and L ^h		10 A		
(3) Where the electrical installation includes one or more 20 A socket-outlets, other than socket-outlets provided to supply electrical equipment set out in groups C, D, E, F, G, and L ^h		15 A		

(continued)

TABLE C1 (continued)

1 Load group	2 Single domestic electrical installation or individual living unit per phase ^a	3 Blocks of living units ^{a, b, c}		
		4 2 to 5 living units per phase	5 6 to 20 living units per phase	6 21 or more living units per phase
		Loading associated with individual units		
C. Ranges, cooking appliances, laundry equipment or socket-outlets rated at more than 10 A for the connection thereof ^h	50% connected load	15 A	2.8 A per living unit	
D. Fixed space heating or air conditioning equipment, space or socket-outlets rated at more than 10 A for the connection thereof ^{h, k}	75% connected load	75% connected load	75% connected load	
E. Instantaneous water heaters ^l	33.3% connected load	6 A per living unit	100 A + 0.8 A per living unit	
F. Storage water heaters ^m	Full-load current	6 A per living unit	100 A + 0.8 A per living unit	
G. Spa and swimming pool heaters	75% of the largest spa, plus 75% of the largest swimming pool plus 25% of the remainder	Loading not associated with individual units—connected to each phase (communal lighting, laundry loadings, lifts, motors, etc.)		
H. Communal lighting ⁿ	Not applicable	Full connected load		
I. Socket-outlets not included in groups J and M below ^{h, m} Permanently connected electrical equipment not exceeding 10 A	Not applicable	2 A per point, up to a maximum of 15 A		

(continued)

TABLE C1 (continued)

Load group	Single domestic electrical installation or individual living unit per phase ^a	Blocks of living units ^{b,c}		
		3 to 5 living units per phase	6 to 20 living units per phase	21 or more living units per phase
		Loading associated with individual units		
J Appliances rated at more than 10 A and socket-outlets for the connection thereof-- (i) Clothesdryers, water heaters, self-heating washing machines, water boilers ^d	Not applicable	50% connected load		
(ii) Fixed space heating, air conditioning equipment, saunas ^e	Not applicable	75% connected load		
(iii) Spa and swimming pool heaters	Not applicable	75% of the largest spa plus 75% of the largest swimming pool, plus 25% of the remainder		
K Lamps	In accordance with Paragraph C2.4.1 and Table C2	In accordance with Paragraph C2.4.1 and Table C2, for determination of size of submain		
L Motors	In accordance with Paragraph C2.4.1 and Table C2, Column 2	In accordance with Paragraph C2.4.1 and Table C2, Column 2		
M Appliances, including socket-outlets other than those set out in groups A to L above, e.g. pottery kilns, welding machines, radio transmitters, X-ray equipment and the like	Connected load 5 A or less: No assessment for purpose of maximum demand Connected load over 5 A: By assessment	Connected load 10 A or less: No assessment for purpose of maximum demand Connected load over 10 A: By assessment		

NOTES TO TABLE C1:

- ^a See Clause 2.2.2 for where the maximum demand for consumers mains, and submains, and the socket-outlets, respectively, may be determined by assessment, measurement or limitation.
- ^b For multiphase connections, divide the number of living units by the number of supply phases, e.g. 18 units on a three-phase supply, 18/3 = 6 units on the nearest loaded phase (Column 4).
- ^c Where only a portion of the number of units in a multiple domestic electrical installation is equipped with permanently connected or fixed appliances, such as electric cooking ranges or space heating equipment, the number of appliances in each category is divided over the number of phases, and the maximum demand determined as shown in Example 3 of Paragraph C2.3.2.
- ^d Lighting track systems shall be regarded as two points per metre of track.
- ^e A socket-outlet installed more than 2.3 m above a floor for the connection of a luminaire may be included as a lighting point in load group A(i). An appliance rated as not more than 100 W, which is permanently connected, or connected by means of a socket-outlet installed more than 2.3 m above a floor, may be included as a lighting point in load group A(i).
- ^f In the calculation of the connected load, the following ratings shall be assigned to lighting:
 - (i) Incandescent lamps: 60 W or the actual wattage of the lamp to be installed, whichever is the greater, except that if the design of the luminaire associated with the lampholder permits only lamps of less than 60 W to be installed in any lampholder, the connected load of that lampholder shall be the wattage of the highest rated lamp that may be accommodated. For multi-lamp luminaire, the load for each lampholder shall be assessed on the above basis.
 - (ii) Fluorescent and other discharge lamps: Full connected load, i.e. the actual current consumed by the lighting arrangement, including the losses of auxiliary equipment, such as ballasts and capacitors.
 - (iii) Lighting tracks (230 V): 0.5 A/m per metre of track or the actual connected load, whichever is the greater.
- ^g Floodlighting, swimming pool lighting, tennis court lighting and the like.
- ^h For the purpose of determining maximum demand, a multiple combination socket-outlet shall be regarded as the same number of points as the number of individual socket-outlets in the combination.
- ⁱ Each item of permanently connected electrical equipment not exceeding 10 A may be included in load group B(i) as an additional point.
- ^j Where an electrical installation contains 10 A or 20 A socket-outlets covered by load group B(ii) or B(iii), the base loading of load group B is increased by 10 A or 15 A respectively. If both 10 A and 20 A socket-outlets are installed, the increase is 10 A.
- ^k Where an electrical installation includes an air conditioning system for use in hot weather and a heating system for use in cold weather, only the system that has the greater load shall be taken into account.
- ^l In water-heater, water heaters, including 'quick recovery' heaters having element ratings greater than 100 W/L.
- ^m Storage-type water heaters, including 'quick recovery' heaters, not referred to in footnote l.
- ⁿ This load group is not applicable to socket-outlets installed in communal areas but connected to the individual living units. Such socket-outlets should be included in load group B.