



**COLLEGE OF ENGINEERING, SCIENCE AND TECHNOLOGY
SCHOOL OF ELECTRICAL AND ELECTRONIC ENGINEERING**

TRADE DIPLOMA IN ELECTRICAL ENGINEERING, STAGE 5

EEE576 ELECTRICAL CIRCUIT DESIGN AND APPLICATION

EXAMINATION (TRIMESTER 2, 2019)

DATE/TIME/ROOM – Refer to Exam Timetable

INSTRUCTIONS TO CANDIDATES

1. You are allowed 10 minutes extra time during which you are not to write.
2. Write all your answers in the allocated Answer Booklet.
3. Begin each answer on a fresh new page and use both sides of the sheets.
4. Write your identification number on the top of each attached sheet.
5. Insert all written foolscaps, graph paper, drawing paper, etc in their correct sequence and secure with string provided.
6. For all sheets of paper in which has been done, cross it through and you must attach to your answer script.
7. Write clearly the number(s) of the question(s) attempted on the top of each sheet and in the back flap of your answer booklet.
8. There are 4 Compulsory Questions in this Exam Paper.

Q1	Electrical Supply Networks and Alarm Systems	23 Marks
Q2	Maximum Demand Calculation	32 Marks
Q3	Circuit Designing/Protection	30 Marks
Q4	Measurement in Power System	15 Marks
	Total Marks	100

**QUESTION 1 - ELECTRICAL SUPPLY NETWORKS AND ALARM SYSTEMS
(23 MARKS)**

- 1.1 An eight storey commercial building requires a transformer supplying each levels. Each levels require 2 distribution boards. Design by sketching a typical *Single Rising Main* for this application. State 2 advantages of the *single rising main* type of supply. (5 marks)
- 1.2 Discuss how switchgears, transformers and switches play a vital part in the transmission of electrical power. (5 marks)
- 1.3 Discuss upon three main advantages of three phase supply over single phase ones. (5 marks)
- 1.5 Discuss the principles of an ionization type of smoke detector. (8 marks)

QUESTION 2 - MAXIMUM DEMAND CALCULATION (32 MARKS)

- 2.1 Determine the maximum demand and the mains aerial cable size if connected through a circuit breaker for a single phase, domestic installation that comprises :
- 41 x lighting points
 - 2 x 15A plug socket outlets
 - 8 x single and 4 x double 10A socket outlets
 - 1 x 3kW range
 - 4.8 kW controlled-load water heater
 - 5 x 300W floodlights in swimming pool area. (16 marks)

Tabulate your answer using the header as shown below :

Load ref	Load Group Description	Calculation	Demand (A)
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- 2.2 Determine the maximum demand of the heaviest loaded phase in a three phase domestic electrical installation comprising :

- 26 lighting points
- 24 x 10A single outlets
- 1 x 15A socket outlets
- 1 x 16.6 kW range
- 1 x 4kW air conditioning unit (Turn over page)

1 x 12.96 kW instantaneous water heater

1 x 3.6kW clothes dryer

(16 marks)

QUESTION 3 - CIRCUIT DESIGNING/PROTECTION (30 MARKS)

3.1 The five main factors affecting an electrical installation are *External Influence*, *Intended Use*, *Maximum Demand*, *Sources of Harmonic Current* and *Circuit Arrangements*. Briefly discuss how these five factors determine the success of an installation.

(10 marks)

3.2 Distinguish the features of a *ring main* and a *radial main* system. Use sketches to elaborate your discussion.

(10 marks)

3.4 Discuss the operation of Current ELCB and a voltage ELCB. Use diagram to show the difference.

(10 marks)

QUESTION 4 - MEASUREMENTS IN POWER CIRCUITS (15 MARKS)

4.1 *Instrument transformers* play a vital role in the display of data/measurement in electrical networks. State the three main tasks of *instrument transformers*.

(3 marks)

4.2 A bar type current transformer which has 1 turn on its primary and 200 turns on its secondary is to be used with a standard range ammeter that has an internal resistance of 0.5Ω . The ammeter is required to give a full scale deflection when the primary current is 600 A.

Determine :

(a) the secondary current (1.5 marks)

(b) the voltage across the ammeter (1.5 marks)

(c) the secondary voltage if the CT is used on a 415V three phase power line.

(2 marks)

(d) Comment on your answer in (c) , what does it tell you about CTs and what can be done to minimize the danger, if any?

(2 marks)

4.3 Show using diagram how you can ground a CT for metering on both sides of a transformer .

(5 marks)

ANNEX 1

**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 4 5 Blocks of living units ^{a,b,c}		
		2 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		
A. Lighting				
(i) Except (ii) 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
(ii) Outdoor lighting exceeding a total of 1000 W ^g	75% connected load	No assessment for the purpose of maximum demand		
B.				
(i) Socket-outlets not exceeding 10A ^{e,h} . Permanently connected electrical equipment not exceeding 10 A and not included in other load groups	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 + 1.9 A per living unit
(ii) 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		
(iii) 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 4 5 Blocks of living units ^{a,b,c}		
		2 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—	Not applicable	50% connected load		
(i) Clothesdryers, water heaters, self-heating washing machines, wash boilers ^h				
(ii) Fixed space heating, airconditioning equipment, saunas ^k	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. Lifts	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 submains		
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 10 A or less: No assessment for purpose of maximum demand		
	Connected load over 5 A: By assessment	Connected load over 10 A: By assessment		

TABLE C1 (continued)

1	2	3	4	5
Load group	Single domestic electrical installation or individual living unit per phase ^a	Blocks of living units ^{a,c}		
		2 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		
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 airconditioning equipment, saunas 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 ^{l,g}	Not applicable	Full connected load		
I. Socket-outlets not included in groups J and M below ^{h,j,n} . Permanently connected electrical equipment not exceeding 10 A	Not applicable	2 A per point, up to a maximum of 15 A		


(continued)

NOTES TO TABLE C1:

- ^a See Clause 2.2.2 for where the maximum demand for consumers mains, and submains, and final subcircuits, 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. 16 units on a three-phase supply, $16/3 = 6$ units on the heaviest 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 G2.3.2.
- ^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 at not more than 150 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 inserted 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 luminaires, 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 phase 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 integral 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 15 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 15 A and 20 A socket-outlets are installed, the increase is 15 A.
- ^k Where an electrical installation includes an airconditioning system for use in hot weather and a heating system for use in cool weather, only the system that has the greater load shall be taken into account.
- ^l Instantaneous 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.

ANNEX 2

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 (mm²)	Protective device rating (I_n)				
	(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	18	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