FNU FIJI NATIONAL UNIVERSITY

COLLEGE OF ENGINEERING, SCIENCE & TECHNOLOGY (CEST)

SCHOOL OF ELECTRICAL & ELECTRONICS ENGINEERING

CERTIFICATE IV IN ELECTRICAL ENGINEERING

EEE449 ELECTRICAL INSTALLATION TECHNOLOGY 2

FINAL EXAMINATION – TRIMESTER 3, 2015

DATE/DAY: TBA **TIME**: TBA
ROOM: AS PER TIMETABLE

INSTRUCTIONS TO STUDENTS

1. You are allowed **10 minutes** extra **reading time** during which you are **NOT** 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 attached sheet.
4. Insert all written foolscaps, graph paper, drawing paper, etc. in their correct sequence and secure with a string.
5. For all sheets of paper on which rough/draft work has been done, cross it through and ATTACH these to your answer scripts.
6. Write clearly the number(s) of the question(s) attempted on the top of each sheet.
7. Use of programmable calculator(s) is prohibited.
8. **ANSWER ALL QUESTIONS**
9. Show all working where necessary.
10. **ALWAYS CHECK YOUR WORK BEFORE YOU LEAVE THE EXAM ROOM**

SECTION A **(50 MARKS)**

1. State any 3 requirements for choosing the correct range of circuit breakers or fuses to protect wiring considering over-load and short circuit protection. (3 marks)

2. With help of a diagram, show the fault current path in an MEN system and give two factors that limited the fault current. (3 marks)

3. Define the following terms in regards to rewireable fuses.
   a) Pre-Arching Time
   b) Fusing Factor
   c) Category of Duty (3 marks)

4. Once the arrangement of circuits is decided the cables for each circuit are selected, before this can be done a number of interrelated factors must be well thought out. Apart from the economic aspects the installation designer must take into account 4 factors and they are. (10 marks)

5. Classify four (4) types of RCD and the current limits. (4 marks)

6. Calculate the available short circuit current of a three-phase 415V transformer if the fault level of a transformer is given as 20 MVA. (3 marks)

7. What type of cables should be used for emergency lighting and for the wiring of fire alarm systems? (3 marks)

8. State the appropriate position to mount a call point for a fire alarm. (2 marks)

9. State the locations in which emergency lights are desired. (2 marks)

10. What is a voltage surge and name two types used. (4 marks)

11. Illustrate how 3 phase supply distribution takes place in a three floor building with individual distribution boards for each level including essential components such as meters, isolators, distribution boards and main switch board. (5 marks)

12. State the four (4) methods of determining Maximum Demand and explain the application for each. (8 marks)

SECTION B **(50 MARKS)**

1. A factory complex is supplied directly from a supply transformer. Transformer rating: 500 kVA 11 kV- 400/230V with an impedance of 4%. Consumers Mains: 3x 400 mm^2 + 1x 150 mm^2 V-75 single sheathed cables installed in underground duct and route length of 14 m.
   a) Determine the maximum fault current and impedance of the transformer given Cos ϕ = 0.25.
   b) Express this impedance in the resistive and reactive components, as R_{TX} and X_{TX}. (Refer to the impedance triangle).
   c) The reactance and resistance of the consumers mains $X_{CM} = 0.0011\Omega$, $R_{CM} = 0.009\Omega$. Determine the impedance of the supply network at the main switchboard.
   d) Determine the prospective short-circuit current at the main switchboard.

(10 Marks)

2. Calculate the fault currents in the circuit shown in (Fig. below) for:
   a) direct earthing system
   b) multiple earthed neutral (MEN) system

(10 marks)

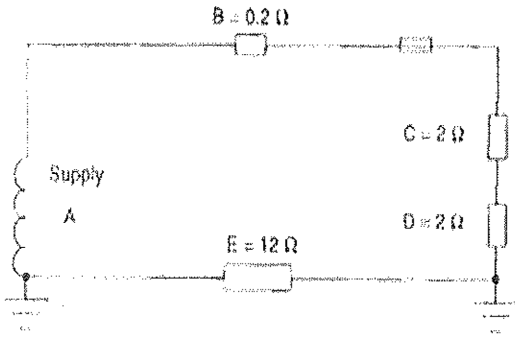

Fig. 12.13 *Path of an earth-fault current: simplified circuit for direct-earthing or ELCB system*

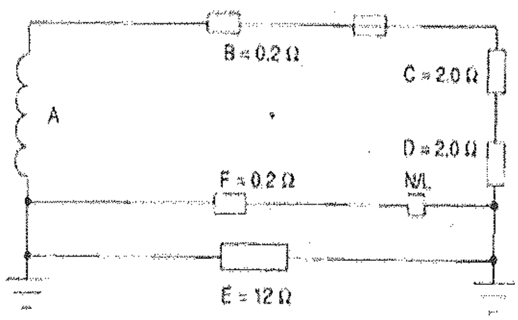

Fig. 12.14 *Path of an earth-fault current: simplified circuit of the MEN system*

3. What is the maximum permissible route length for a three-phase 400 V three-wire circuit, protected by a 30 A C-type circuit breaker, using 6mm^2 thermoplastic-insulated unsheathed V90 copper cables in PVC conduit? Because of voltage drop in the consumers mains, the voltage drop in the circuit is limited to 3.5 per cent. (3 marks)

4. For Question 3 above find out if the length calculated satisfies the **Fault – Loop impedance** limit? If it does not find a suitable solution (7 marks)

5. The following load is connected to a three phase 240/415 volts supply in a domestic installation.
   (a) 31 lighting points
   (b) 12 only G.P.O
   (c) 1 x 3 Phase 8.0 kW range, comprising (5.0kw hotplates , 3.0kw oven)
   (d) 1 x 3 kW air conditioning unit (single phase)
   (e) 1 x 12kW instantaneous water heater (3 phase)
   (f) 1 x 2 kW clothes dryer (single phase)

   Arrange the loads over the three phases so that it is balanced, hence calculate the maximum demand. (10 marks)

6. The particulars of an installation from the commencement of the consumers mains to a 3.6kW air conditioner as final sub-circuit are given below. Find the,
   a) Total voltage drop incurred
   b) Most practical solution if the voltage drop is not in the permissible limits

   Consumers mains (1Ø) Length - 10m
   Current - 70A
   Cable - (V75) 16mm^2

   Submains (1Ø) Length - 20m
   Current - 40A
   Cable - (V75) 6mm^2

   Final Subcircuit (1Ø) Length - 12m
   Current - 16A
   Cable - (V75) 1.5mm2

(10 marks)

The End

TABLE C1

MAXIMUM DEMAND—SINGLE AND MULTIPLE DOMESTIC ELECTRICAL INSTALLATIONS

1	2	3	4	5
Load group	Single domestic electrical installation or individual living unit per phase[a]	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 for (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[f,g]	75% connected load	No assessment for the purpose of maximum demand		
B (i) Socket-outlets not exceeding 10 A[e,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 + 1.9 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,j]	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,j]	15 A			

(continued)

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,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		
C Ranges, cooking appliances, laundry equipment or socket-outlets rated at more than 10 A for the connection thereof[j]	50% connected load	15 A	2.8 A per living unit	
D Fixed space heating or air-conditioning equipment, saunas or socket-outlets rated at more than 10 A for the connection thereof[j,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[f,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)

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,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— (i) Clothes dryers, water heaters, self-heating washing machines, wash boilers[h]	Not applicable	50% connected load		
(ii) Fixed space heating, airconditioning equipment, saunas[f]	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 C7

VOLTAGE DROP—SIMPLIFIED METHOD

Cable conductor size	Single-phase (230 V) circuit	Three-phase (400 V) circuit
	Am per $\%V_d$	Am per $\%V_d$
1 mm^2	45	90
1.5 mm^2	71	142
2.5 mm^2	128	256
4 mm^2	205	412
6 mm^2	306	615
10 mm^2	515	1 034
16 mm^2	818	1 643
25 mm^2	1 289	2 588
35 mm^2	1 773	3 560
50 mm^2	2 377	4 772
70 mm^2	3 342	6 712
95 mm^2	4 445	8 927

Table C7 provides a simple tabulation of the terms $(10 \times V_a)/V_c$ developed using values for V_c from the AS/NZS 3008.1.1 series for common PVC/PVC cable types operating at 75°C, and 230 V and 400 V for single-phase and three-phase circuits respectively.