



**SCHOOL OF ELECTRICAL AND ELECTRONIC ENGINEERING**

**CERTIFICATE IV IN ELECTRICAL ENGINEERING**

**EEE395- ELECTRICAL INSTALLATION TECHNOLOGY 1**

**FINAL EXAMINATION PAPER PENSTER 3– 2017**

**Day/Date: TBA**

**Time: TBA**

**Room: TBA**

**Duration of Exam: 2hrs: 10mins**

**Total No. of Pages: 7 Pages including Tables**

**Total Marks: 100 marks**

**INSTRUCTIONS TO STUDENTS:**

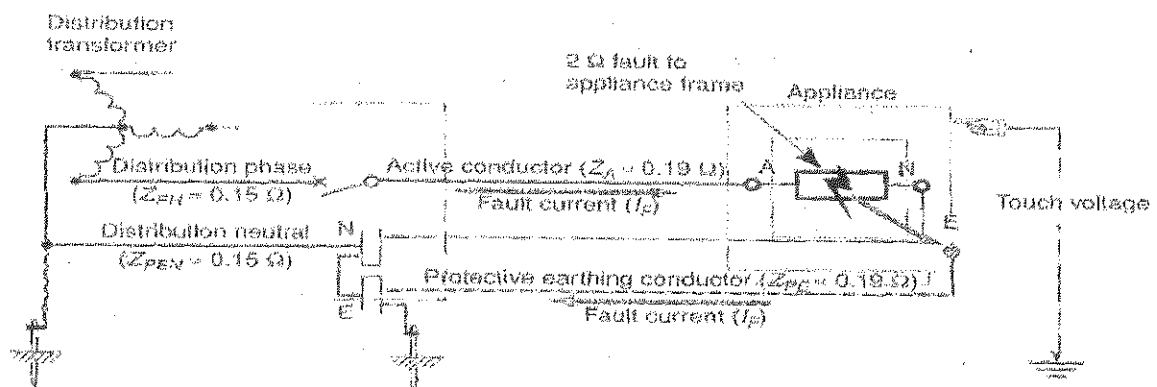
1. You are allowed 10 minutes extra reading time during which you are NOT allowed to write.
2. Begin each SECTION on a fresh page and use both sides of the sheet.
3. Write your candidate number at the top of each answer sheet.
4. Insert all foolscaps, graph paper, drawing paper etc. in their correct 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

**SECTION A****(40 MARKS)**

- List the voltages available for the following :
  - Extra-Low Voltage
  - Low Voltage
  - High Voltage (3marks)
- What are the four (4) methods of determining the maximum demand of an installation? (4 marks)
- What is the standard procedure when using lockout or Tagout? (5 marks)
- Give four (4) advantages of having a country wide grid connected system. (4 marks)
- Draw the appropriate diagram and show the following:
  - Main earthing conductor
  - Main Earthing terminal
  - Earth bar
  - MEN link
  - Protective Earthing Conductor
  - Equipotential bonding conductors (6 marks)
- State four (4) basic components of power system protection. (4 marks)
- State the five (5) basic components of a refrigeration system and briefly explain its purpose. (5 marks)
- Compare the star and delta system in a table form. (5 marks)
- Give four (4) advantages of AC power over DC power. (4 marks)

**SECTION B****(60 MARKS)**

- For the circuit shown below:



- a) Draw the equivalent circuit for earth fault loop.  
 b) Find equivalent Impedance.  
 c) Calculate the fault current.  
 d) Identify the touch voltage. (10 marks)
2. A domestic installation draws a single phase current of 59.08A and is 100m away from the nearest FEA post, what would be the voltage drop incurred if you are using 10mm<sup>2</sup> 2 core insulated hard drawn cable which has a three phase  $V_C$  value of 4.02 mV/Am? Using the Table C7 prove cable size is correct. (10 marks)
3. Determine the maximum demand of the heaviest loaded phase in a domestic electrical installation comprising of:  
 26 × Lighting points  
 24 × 10A single-phase single socket-outlets  
 1 × 15A single-phase socket-outlet  
 1 × 16600W 3φ electric range consisting of 2 - 5000W hotplates and one 6600W oven  
 1 × 4000W single-phase air-conditioning unit  
 1 × 12960W three-phase instantaneous water heater  
 1 × 3600W single-phase clothes dryer and arranged for connection across a three-phase supply as follows:
- | RED                              | WHITE                            | BLUE                             |
|----------------------------------|----------------------------------|----------------------------------|
| 15A Socket Outlet                | 15- 10A Socket Outlets           | 26 Lights                        |
| 5000W Hot Plate                  | 5000W Hot Plate                  | 9- 10A Socket Outlets            |
| 4000W Air Conditioner            | 3600W clothes Dryer              | 6600W Oven                       |
| 4320W Instantaneous Water Heater | 4320W Instantaneous Water Heater | 4320W Instantaneous Water Heater |
- (10 marks)
4. Draw the schematic representation of vapour compression refrigeration cycle and label the diagram. (10 marks)
5. Draw a single line diagram showing the supply of electricity from Monasavu to FNU Samabula or BA campus. (The diagram MUST include the voltage levels, transformer type used and the isolators.) (10 marks)
6. As an electrician you are to erect a 100A, three-phase aerial line using a four-core, 16mm<sup>2</sup> hard-drawn insulated copper cable, a distance of 19 m over an area used by vehicles. Determine Pole/post size and allowable span. (10 marks)

**END OF PAPER**

**TABLE 5.1**  
**MINIMUM COPPER EARTHING CONDUCTOR SIZE**

Nominal size of active conductor mm <sup>2</sup>	Nominal size of copper earthing conductor, mm <sup>2</sup>	
	With copper active conductors	With aluminium active conductors
	1	1
1.5	1.5	—
2.5	2.5	—
4	2.5	—
6	2.5	—
10	4	—
16	5	4
25	6	6
35	10	6
50	16	10
70	25	10
95	25	16
120	35	25
150	50	25
185	70	35
240	95	50
300	120	70
400	≥120*	≥95*
500	≥120*	≥95*
630	≥125*	≥120*

**TABLE B1**  
**MAXIMUM CIRCUIT LENGTHS, IN METRES, FOR DIFFERENT SIZES OF CONDUCTORS AND PROTECTIVE DEVICES USING APPROPRIATE MEAN TRIPPING CURRENTS (I<sub>a</sub>)\***

Conductor size		Protective device rating A	Circuit-breaker (see Note 1)			Fuses (see Note 2)
Active mm <sup>2</sup>	Earth mm <sup>2</sup>		Type B	Type C	Type D	
Maximum circuit length, L <sub>max</sub> , m						
1	1	6	170	51	55	204
1	1	10	102	55	33	174
1.5	1.5	10	163	52	42	170
1.5	1.5	16	96	51	31	92
2.5	2.5	16	160	55	51	136
2.5	2.5	20	126	58	41	95
4	2.5	25	128	67	45	90
4	2.5	32	98	52	37	70
6	2.5	40	90	48	29	60
10	4	50	117	62	37	73
16	6	63	142	75	46	85
16	6	80	112	59	36	69
25	6	80	124	66	40	68
25	6	100	98	53	32	47
35	10	100	156	65	51	75
35	10	125	127	55	41	55
50	16	125	168	105	63	90
50	16	160	155	83	50	71
70	25	160	205	126	75	108
70	25	200	156	100	60	84

TABLE C1

MAXIMUM DEMAND—SINGLE AND MULTIPLE DOMESTIC ELECTRICAL INSTALLATIONS

Load group	Single domestic electrical installation or individual living unit per phase <sup>a</sup>	Blocks of living units <sup>a,b,c</sup>		
		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), see load group H below <sup>d,e</sup>	1 A for 1 to 20 points + 0.5 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 <sup>f,g</sup>	75% connected load	No assessment for the purpose of maximum demand		
B (i) Socket-outlets not exceeding 10 A <sup>h</sup> , permanently connected electrical equipment not exceeding 10 A, and not included in other load groups <sup>i</sup>	10 A for 1 to 20 points + 1 A for each additional 20 points or part thereof	10 A + 0.5 A per living unit	15 A + 1.25 A per living unit	50 A + 1.0 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 <sup>j</sup>		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 <sup>k</sup>		15 A		

(continue on)

TABLE C1 (continued)

Load group	Single domestic electrical installation or individual living unit per phase <sup>a</sup>	Blocks of living units <sup>a,b,c</sup>		
		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 <sup>l</sup>	75% connected load	10 A	2.5 A per living unit	
D. Fixed space heating or air-conditioning equipment, saws or socket-outlets rated at more than 10 A for the connection thereof <sup>m</sup>	75% connected load	75% connected load	75% connected load	
E. Instantaneous water heaters <sup>n</sup>	25-33% connected load	6 A per living unit		100 A + 0.5 A per living unit
F. Storage water heaters <sup>o</sup>	Full-load current	6 A per living unit		100 A + 0.5 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 <sup>p,q</sup>	Not applicable	Full connected load		
I. Socket-outlets not included in groups J and M below <sup>r,s</sup> , permanently connected electrical equipment not exceeding 10 A	Not applicable	2 A per point, up to a maximum of 15 A		

**TABLE C7  
VOLTAGE DROP—SIMPLIFIED METHOD**

Cable conductor size	Single-phase (230 V) circuit	Three-phase (400 V) circuit
	Am per %V <sub>s</sub>	Am per %V <sub>s</sub>
1 mm <sup>2</sup>	45	90
1.5 mm <sup>2</sup>	70	140
2.5 mm <sup>2</sup>	128	258
4 mm <sup>2</sup>	205	412
6 mm <sup>2</sup>	306	616
10 mm <sup>2</sup>	515	1 034
16 mm <sup>2</sup>	515	1 034
25 mm <sup>2</sup>	739	1 588
35 mm <sup>2</sup>	773	1 580
50 mm <sup>2</sup>	977	1 972
70 mm <sup>2</sup>	1 342	2 712
90 mm <sup>2</sup>	1 445	2 927

**TABLE 3.9  
AERIAL CONDUCTOR MAXIMUM SPANS**

Type of conductor	Size (mm <sup>2</sup> )	Maximum span (m)
Insulated annealed copper including neutral-screened	16	20
Bare hard-drawn copper	16	50
Insulated hard-drawn copper including two-, three- and four-core twisted but excluding neutral-screened	6	40
	10	50
	25	50
Neutral-screened cables with hard-drawn copper conductors	two conductors	6 or 10
	three conductors	6 or 10
	four conductors	6 or 10
	two, three, or four conductors	10
	Insulated or bare aluminium excluding neutral-screened	16
	22.5	60
Aerial bundled cables (aluminium conductor)	22.5	60

**TABLE 3.8  
MINIMUM AERIAL CONDUCTOR CLEARANCES**

All dimensions in metres

Type of aerial conductor	Minimum height above buildings, structures, ground or elevated areas				From buildings: Horizontal clearance from walls, etc.	From clothes lines, radio and television aerials, counterpoise or stay wires	From telecommunication lines (see Note 2)	Above swimming pools	Above areas where sailing craft, or irrigation pipes are used (see Note 3)
	Over areas used by vehicles	Over areas not used by vehicles	Over roofs used for traffic or resort	Over other roofs and structures					
Bare live conductors	5.5	5.0	3.7	3.0	2.0	2.0	1.2	Not permitted	Not permitted
Insulated and cross-linked live conductors	4.0	3.0	3.0	2.0	1.0	2.0	0.6	3.0	5.0
Neutral-screened cable	4.0	3.0	2.7	2.0	1.0	2.0	0.6	3.0	4.5

**TABLE D1  
SINKING OF POSTS/POLES IN GROUND**

Free length to lowest conductor support (m)	Depth in ground (metres)		
	Poor soil	Medium soil	Good soil
2.0	1.0	1.0	1.0
2.5	1.0	1.0	1.0
3.0	1.0	1.0	1.0
3.5	1.2	1.0	1.0
4.0	1.5	1.0	1.0
4.5	1.8	1.0	1.0
4.8	1.8	1.0	1.0
5.1	1.8	1.0	1.0
5.4	1.8	1.0	1.0
5.7	1.8	1.0	1.0
6.0	1.8	1.0	1.0
6.3	1.8	1.0	1.0
6.6	1.8	1.0	1.0
6.9	1.8	1.0	1.0
7.2	1.8	1.0	1.0

**TABLE D2  
FORCE EXERTED BY AERIAL LINE CONDUCTORS**

Aerial line conductor sizes	Total weight of all conductors (kg/m)	Aerial line span (m)	Minimum aerial line sag (m)	Maximum allowable aerial line sag (m)	Normal aerial line tension (kN)	Minimum aerial line breaking tension (kN)	Minimum pole or strut strength
							Rating
Single-phase lines 2 - Singles or 1 - 2 core 6 mm <sup>2</sup> up to 16 mm <sup>2</sup> Copper conductors (DC)	0.25 Max	10	0.08	0.2	0.45	12.4	54
		15	0.11	0.4	0.68		67
		20	0.25	0.8	0.87		84
		30	0.43	1.5	0.92		115
		40	0.57	1.9	1.03		133
Single-phase lines 2 - Singles or 1 - 2 core 18 mm <sup>2</sup> up to 25 mm <sup>2</sup> Aluminum conductors (AC)	0.2 Max	10	0.09	0.2	0.45	7	55
		15	0.11	0.4	0.68		68
		20	0.26	0.8	0.88		85
		30	0.45	1.5	0.93		116
		40	0.57	1.9	1.04		134
Three-phase lines 4 - Singles or 1 - 4 core 6 mm <sup>2</sup> up to 16 mm <sup>2</sup> or 18 mm <sup>2</sup> up to 25 mm <sup>2</sup> Al	0.4 Max	10	0.08	0.2	0.66	14	55
		15	0.11	0.4	0.66		68
		20	0.26	0.8	0.77		85
		30	0.43	1.5	1.05		116
		40	0.57	1.9	1.40		136
Three-phase lines up to max 4 - 1/2 - 18 mm <sup>2</sup> Cu singles or 1 - 4 core 40 mm <sup>2</sup> Al	1.05 Max	10	0.09	0.2	1.98	65.2	65
		15	0.11	0.4	2.15		82
		20	0.26	0.8	2.07		100
		30	0.59	1.5	2.57		128
		40	0.84	2.0	3.07		156
Three-phase lines up to max 4 - 1/2 - 6 mm <sup>2</sup> Cu or 2 - 4 core 95 mm <sup>2</sup> Al	2.7 Max	10	0.08	0.2	3.75	100.4	65
		15	0.11	0.4	4.47		82
		20	0.26	0.8	5.14		100
		30	0.69	1.5	6.14		128
		40	1.05	2.0	7.14		156