COLLEGE OF ENGINEERING, SCIENCE & TECHNOLOGY (CEST)

SCHOOL OF ELECTRICAL & ELECTRONICS ENGINEERING

CERTIFICATE IV IN ELECTRICAL ENGINEERING-STAGE 5

EEE449 ELECTRICAL INSTALLATION TECHNOLOGY C

FINAL EXAMINATION – PENSTER 4, 2014

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 **(60 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. State the principle of operation of a RCD. (3 marks)

3. 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)

4. A three phase 240V/415V 500 KVA transformer is supplying load through mains and bus-mains. If the impedance of the transformer is given as 3% and impedance per phase of the mains is 0.0050 and the sub-main is 0.025.

   Calculate the fault current at:
   (a) transformer
   (b) main switchboard
   (c) sub-board (9 marks)

5. How would you carry out the following tests on a new installation wiring before power is switched on?

   (a) polarity test
   (b) Insulation resistance test (6 marks)

6. State 3 major reasons for *Earthing*. (3 marks)

7. With the help of a diagram, show the fault current path and accordingly explain what fault loop impedance is. (4 marks)

8. Explain the operation of thermal-magnetic trip miniature circuit breaker. (3 marks)

9. What is a voltage surge and how is it generated? (2 marks)

10. Suppose you do not have access to an earth rod, what alternative method you can use to meet the earthing requirements? (2 marks)

11. Illustrate and explain one of the cable joining methods (3 marks)

12. Illustrate and explain the street light components and connection, also explain its switching. (3 marks)

13. Illustrate how supply distribution takes place in a three storey building with individual distribution boards for each level including essential components such as meters, isolators, CTs (if required), distribution boards and main switch board. (4 marks)

14. State some precautions and the type of wiring necessary for underwater lights in a swimming pool. (3 marks)

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

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

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

18. Differentiate direct earthing system and multiple earthed neutral (MEN) system (2 marks)

SECTION B (40 MARKS)

1. What does the term "current carrying capacity" of a conductor mean and state two diversity factors that affect the current carrying capacity of a conductor? (3 marks)

2. a)The following loads are connected to a three phase 240/415 volts supply in a domestic installation.
   (a) 31 lighting points
   (b) 12 x single socket outlets 10A
   (c) 1 x 3 phase 8.0 kW range, comprising (5kw hotplates , 3kw oven)
   (d) 1 x 3 kW air conditioning unit (single phase)
   (e) 1 x 3 phase 12 kW instantaneous water heater
   (f) 1 x 2.0 kW clothes dryer (single phase)

   Arrange the loads over the three phases so that it is balanced, hence calculate the maximum demand. (15 marks)

   b) For the above installation, the route length of consumer's mains is 20 m. Using the maximum demand from above plus allowing for an additional 40% for future loads, find the size of cables to be used for the mains if permissible voltage drop is estimated as 3%. (Reference: table attached at the back) (4 marks)

c) Given the following information, find the voltage drop incurred in the sub-mains and the final subcircuit (Reference: table attached at the back)

i)	Submains (1Ø)	Length	-	20m
		Current	-	40A
		Cable	-	(V75) $6mm^2$
ii)	Final Subcircuit (1Ø)	Length	-	15m
		Current	-	15A
		Cable	-	(V75) $1.5mm^2$

(6 marks)

3. Indicate the protective device rating for the following type of conductors used for specific applications: (Reference: Wiring Rule book)

   a) $6mm^2$ two core and earth, flat cable installed unenclosed in air used in single phase applications.

   b) $4mm^2$ - two core and earth, flat cable installed enclosed in air used in single phase applications

(4 marks)

4. Explain the radial and ring systems of distribution (4 marks)

5. How do you provide *earthing* on a ship? (2 marks)

6. What provision one should allow for whilst distributing load in a building? (2 marks)

########## End of paper ##########

MARKING SCHEME

School:	Electrical & Electronic Engineering
Course:	Certificate IV in Electrical Engineering
Title:/Code:	**ELECTRICAL INSTALLATION TECHNOLOGY C / EEE449**
Stage/Penster/Year:	CTEEL 5 / Penster 4 / Year 2014
Date:	**TBA**
Examiner:	Sumendra Kumar

CONFIDENTIAL

Model Answers and Marking Scheme

NOTE: Give a clear indication of answers expected and marks allocated for each part of a question.

SECTION A

1. The requirements for the protection of wiring are:

   -The fuse or circuit breaker should be capable of carrying its rated current continuously without overheating or deterioration
   -Small overloads of short duration should not cause the protection to operate
   -The protection must operate, even on a small overload, if the overload persists long enough to cause over-heating of the circuit conductors
   -The protection must open the circuit before damage caused by fault currents can occur
   -Protection must be 'discriminative' in that only the faulty circuit is isolated and other circuits remain operative and unaffected
   (Any 3 from above carries 1 mark each)

2.

14.3 Operating principle

The RCD uses a toroidal transformer, similar to a current transformer, to detect leakage current. The secondary winding is known as the 'sensing winding' or 'fault detection winding'. It is connected to a trip relay, which, when activated by an earth leakage current, operates main contacts to switch off the circuit. The active and neutral conductors supplying the circuit to be protected are installed so that they pass through the toroidal core (see Fig. 14:3). A toroidal transformer is one where the winding uses a circle as an axis.

(3 marks)

3.

$$MVA = \frac{\sqrt{3}\times VI}{10^6}$$

$$I\ fault = \frac{MVA\times 20^6}{\sqrt{3}\times 415}$$

$$= \frac{20\times 10^6}{\sqrt{3}\times 415}$$

$$= 27824.11\ \text{Amps}$$

(3 marks)

4. Full Load Current $= \frac{KVA}{\sqrt{3\times V}}$

$$= \frac{500\times 10^3}{\sqrt{3}\times 415}$$

= **<u>695.6 Amps</u>**

(3 marks)

a) Fault current at transformer

$$= \underline{\mathbf{695.6}} \text{ x } \frac{100}{3}$$

$$= \underline{\mathbf{23{,}186.75Amps}}$$

(1 mark)

Now the transformer impedence

$$Z_1 = \frac{240}{I_{fault}}$$

$$= \frac{240}{23186.75}$$

$$= \mathbf{0.01035}$$

(1 mark)

b) Fault current at main switchboard

$$= \frac{240}{Z_1 + Z_2}$$

$$= \frac{240}{0.01035 + 0.0050}$$

$$= \underline{\mathbf{15{,}\ 634.38\ Amps}}$$

(2 marks)

c) Fault current at sub-board.

$$= \frac{240}{0.01035 + 0.0050 + 0.025}$$

$$= \underline{\mathbf{5947.96\ Amps}}$$

(2 marks)

5. <u>a) Polarity Test</u>

Disconnect the earth wire from the neutral link and test with a voltmeter or test lamp. Test lamp will light or voltmeter will give full voltage reading between active supply line and earth wire. There will no reading between neutral line and earth. (3 marks)

<u>b) Insulation Resistance Test</u>

Use megger to do insulation resistance test on circuit conductors. High readings in MΩ shall be obtained between all conductors. Any low reading will indicate an insulation breakdown. (3 marks)

6. - Electric Shock
   - Electrically initiated fire
   - Voltage stability

(1 mark each total: 3 marks)

7.

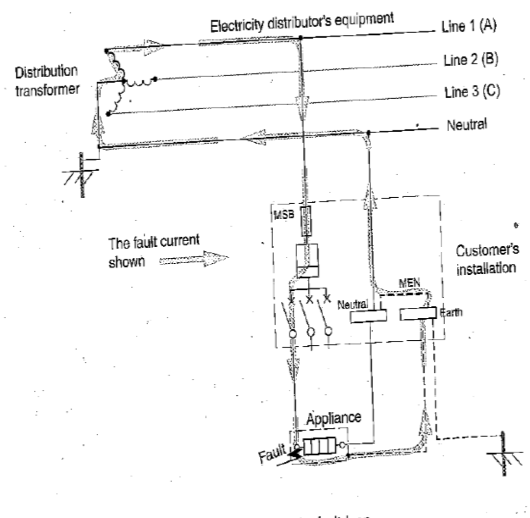


Fig. 12.5 The path taken by an earth fault current known as the fault loop

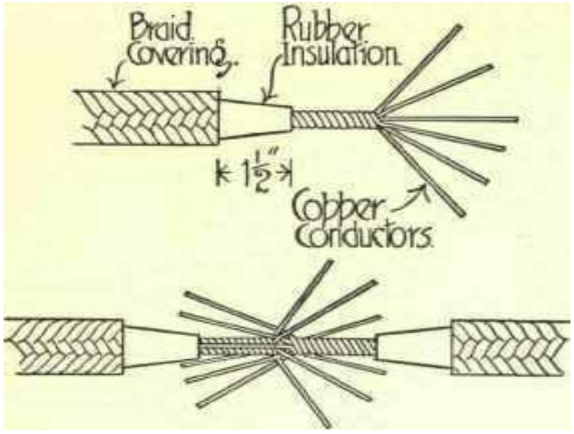
The fault loop impedance is obviously the sum of the impedances of each conductor in the fault loop, remembering that the impedance (mostly resistance) of a conductor depends on its size and length (4 marks)

8. It is a combination of bi-metallic strip and an electromagnet. The bi-metallic strips expands and bends to cut-off when there is high temperatures whereas an electromagnet energizes when there's a fault current flowing. (3 marks)

9. In an installation, nuisance tripping of RCDs may be caused by voltages higher than the normal. These high voltages are variously known as 'voltage surges', 'overvoltage', ' voltage transients', 'voltage spikes' etc. The cause of the over-voltage might be within the installation or external to it. It is generated by lightning and cyclic switching (2 marks)

10. Use bare 35 mm^2 copper cable 3 meters long laid flat in ground at a depth of 1.5m (2 marks)

11. Married joint

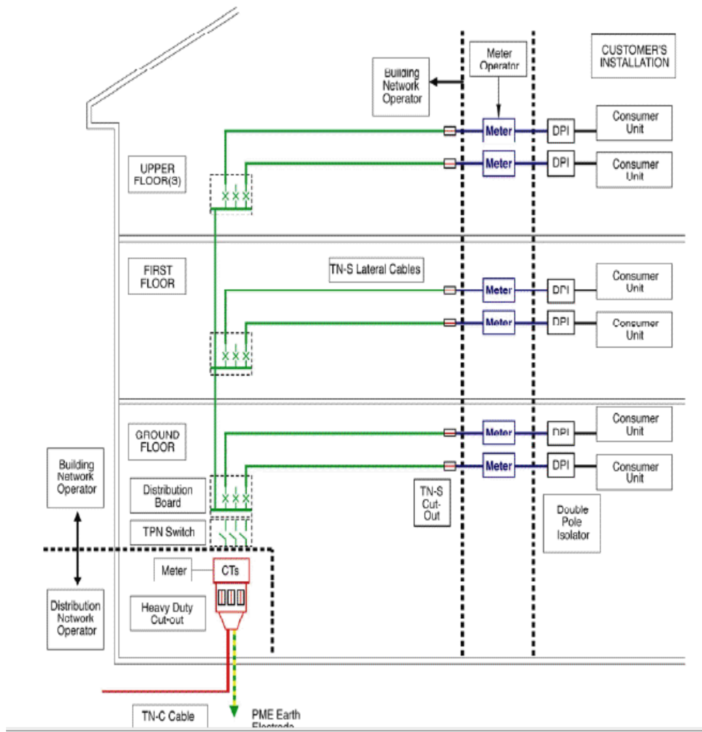


(3 marks)

12.

There could be a range of answers but a diagram that covers majority components is accepted (3 marks)

13.



(4 marks)

14. Extra low voltage would be used, lighting is done in HD conduits and it's sealed not letting the wires to come in contact with moisture. Weather proof mountings are used as well as ELV lights that can sustain in water. It will also be protected by RCD. (3 marks)

15. MIMS, pyrolex cables and cables specified in wirings rule book for such installation. (3 marks)

16. It should be 1.4 m from the floor and should be easily accessible (2 marks)

17. Exit points, stairs, etc .In dark rooms and multi-storey buildings where when power goes down causes a dark environment and it's sometimes used in conjunction with fire alarms.

(2 marks)

(3

18. Neutral not connected to earth in direct earthing whereas neutral is connected to earth in a MEN system (2 marks)

Section B **(40 marks)**

1. It is the current that the conductor can carry in the presence of the diversity factors which derate the value of current. Two factors are environmental conditions and method of installation

(3 marks)

2. a)

Lights	31 lights	Nil	Nil
G.P.O's	Nil	12 Socket Outlets	Nil
A/C	Nil	Nil	3kW A/c unit.
Range	5Kw hot plate	3Kw oven	
Water heater	4 KW	4 KW	4KW
Cloth dryer	Nil	2.0 KW	Nil

LOADS	RED	WHITE	BLUE
Lights	3 + 2 = 5 Amps		
GPOs		10 Amps	
A/Con			$\frac{3000}{240} \times \frac{75}{100} = 9.375$
Range	$\frac{5000}{240} \times \frac{50}{100} = 10.42$		$\frac{3000}{240} \times \frac{50}{100} = 6.25$
Water heater	$\frac{4000}{240} = \frac{16.67}{3} = 5.5$	$\frac{4000}{240} = \frac{16.67}{3} = 5.5$	$\frac{4000}{240} = \frac{16.67}{3} = 5.5$
Cloths dryer		$\frac{2000}{240} \times \frac{50}{100} = 4.16$	
TOTAL	= 20.92A	= 19.66 A	= 21.13

Heaviest loaded phase is blue phase = 21.13 A (15 marks)

b) I = MD + 0.4MD = 21.13 + 8.45 = 29.58A approx = 30A

$$Vc = \frac{1000Vd}{LI} = \frac{1000 \times (12.45)}{20 \times 30} = 20.75 Mv/Am$$

From table 42, you will use 2.5 mm^2 4 core + ecc (5 marks)

c) i) $$Vd = \frac{L \times I \times Vc}{1000} = \frac{20 \times 40 \times 7.5}{1000} = 6\ V$$ (3 marks)

Vc from Table 40 for 6 mm^2 cables is 6.49 (3 phase Vc). Now converting it to 1 phase Vc gives 6.49 x 1.155 = 7.5

ii) $$Vd = \frac{L \times I \times Vc}{1000} = \frac{15 \times 15 \times 33.03}{1000} = 7.43\ V$$ (3 marks)

Vc from Table 40 for 1.5 mm^2 cables is 28.6 (3 phase Vc). Now converting it to 1 phase Vc gives 28.6 x 1.155 = 33.03

3. Table C 5

   a) 40 A
   b) 25 A

(4 marks)

4.

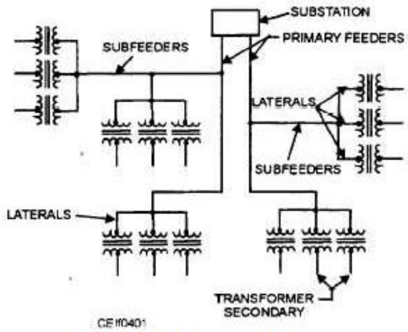
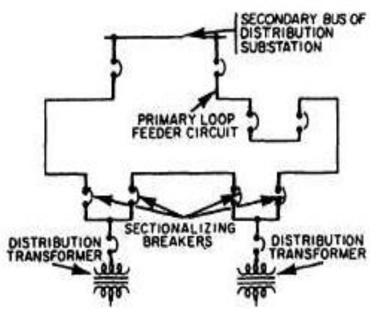


Figure 4-1.—Radial distribution system.

(2 marks)



(2 marks)

5. No main earthing conductor required, in any installation it is connected to the hull of the ship since it is magnetic in nature and it will discharge currents to the high resistance in the sea (2 marks)

6. Should provide an isolator or breaker for future maintenance

(2 marks)

THE END