FIJI NATIONAL UNIVERSITY

COLLEGE OF ENGINEERING, SCIENCE & TECHNOLOGY

SCHOOL OF ELECTRICAL & ELECTRONICS ENGINEERING

CERTIFICATE 4 IN ELECTRICAL ENGINEERING – STAGE 3

EEE395 ELECTRICAL INSTALLATION TECHNOLOGY A

FINAL EXAMINATION – PENSTER 1, 2015

SOLUTIONS

SECTION A (30 MARKS) MULTIPLE CHOICE – ANSWERS.

Question 1. (D). Question 2. (D). Question 3. (C). Question 4. (A), (C), (E).

Question 5. (B). Question 6. (C). Question 7. (A). Question 8. (A), (E).

Question 9. (A), (B), (C). Question 10. (D).

(2 marks is awarded for each correct answer choice)

SECTION B (40 MARKS) BRIEF ANSWERS

Question 1. (3 marks) Answer:

The current carrying capacity of earthing conductors specified in Table 5.1 of the Wiring Rules is obviously intended for very short periods, while at the same time allowing sufficient time for the protective device to operate.

A factor to consider when selecting protective earthing conductors is the resistance, which increases with the route length of the circuit. This in itself is dependent on the maximum fault-loop impedance permitted for each circuit. Remember, the impedance of the fault-loop is that of the series circuit formed by the active conductor and the protective earthing conductor. "In some cases a protective earthing conductor larger than that specified in Table 5.1 might be used to keep the resistance of the fault-loop below its permitted maximum, because of the route length of the circuit. This is the choice of the electrician (or enginner) who design the installation.

Question 2. (3 marks)

Answer:

Section 5 of the Wiring Rules relates earthing conductor sizes to the size of the largest active conductor protected by earthing conductor, and the appropriate sizes are listed in Table 5.1 of the Wiring Rules. Therefore 35 mm^2 copper protective earthing conductor is the appropriate size.

Question 3. (3 marks)

Answer:

The protective earthing conductor, that does not normally carry current, is sized to sustain the fault current for a very short period. Clause 5.5.1

SECTION B (Cont...)

Question 4. (7 marks) Answer:

Separate MEN, a detached portion of a premises, say, another building, which is called an "outbuilding" in the Wiring Rules, might be regarded as a separate MEN installation. In this case a study of **clause 5.5.3.1** reveals a number of points of safety that must be observed.

1. The outbuilding must have only one MEN connection at one distribution board, which is to be treated as a main switchboard.
2. There should not be any possibility to disconnect the sub-main neutral supplying the distribution board at any point in its route.
3. There should be no parallel circuits created with the supply neutral by protective earthing or equipotential bonding within the whole installation.

Question 5. (5 marks) Answer: Clauses 1.4.27 to 1.4.29

Class II equipment essentially protects against insulation breakdown either by encasing all metal parts in insulation, or by interposing two separate layers of insulation (double insulation) between the live parts and any external metal so that both sets of insulation would have to breakdown to constitute a hazard.

1. Basic insulation - the insulation adjacent to the live parts.
2. Supplementary - insulation-second insulation barrier, between the first and the external metal parts. Clause 1.4.60.

Many current-using devices are double insulated, such as kitchen appliances and larger-capacity power tools. They are manufactured to comply with standard approval and test specifications and are marked "DO NOT EARTH-DOUBLE-INSULATED."

Question 6. (3 marks) Answers: Clause 1.4.54

A very important part of earthing in an installation is the bonding of extraneous conductive parts to the earthing system to reduce the risk of a rise in potential between them. Extraneous conductive parts are not part of the electrical installation but may be at local earth potential. Differences in potential can arise from current in the earth resulting from lightning and HV feeders fault discharge to earth. Clause 5.6.2 details the requirements for bonding conductive materials.

Question 7.0 (6 marks) Answers:

1. Do not disconnect the main earth in an energized installation.

2. In a de-energized installation, test that the main earth is not carrying current from another faulty installation before disconnecting it.

3. Before disconnecting a protective earthing conductor, isolate the supply to the circuits where a test shows that the protective earthing conductor is carrying current.

Question 8. (6 marks) Answers:

1. The TN-S earthing system:

   Uses separate protective earthing (PE) and neutral (N) conductors from the supply source to the consumer and within the installation.

2. The TN-C earthing system:

   Uses a combined protective earth-neutral (PEN) conductor from the supply source to the consumer and within the installation.

3. TN-C-S earthing system:

   Uses a combined protective earth-neutral conductor (PEN) from the supply source to consumer's main switchboard, but uses separate protective earth (PE) and neutral (N) conductors within the installation.

Question 9. (4 marks) Answers:

1. Fire started by a short circuit in the TPS junction box. A short circuit between active and earth connectors caused by moisture and dust accumulation in the junction box.

2. Fire started by a poor connection at the terminals of a fixed appliance. The poor connection introduces additional impedance in the normal current path, causing burning at the terminals.

SECTION C (30 MARKS) CALCULATIONS

Question 1. Answers:

Part A (20 marks)

	LOAD GROUP	CALCULATION	DEMAND CURRENT	
A (i)	23 lighting points	3 + 2 = 5A	5.0	(2)
A (ii)	4 × 300 W floodlights	$\frac{4\times300}{230} \times 0.75 = 3.9$ A	3.9	(2)
B (i)	6 single + 10 double socket outlets	10 + 5 = 15 A	15.0	(2)
B (ii)	2 × 15 A socket outlets	Allow 10 A	10.0	(2)
C	10 kW range	$\frac{10000}{230} \times 0.5 = 21.7\ A$	21.7	(2)
F (i)	4.8 kW controlled-load water heater	$\frac{4800}{230} = 20.9\ A$	20.9	(2)
Maximum Demand:			76.5 i.e. 77.0 A	(3)

Part B (5 marks)

1. Cable size (Table 42), MD = 77 A @ Vc = 7.468 m.V/A.m, cable size = 6.0 mm^2 (1 mark)
2. Type of cable: Single phase TPS/PVC Orange round cable (1 mark)
3. Calculated cable size:

$$Vc = \frac{1000 \times Vd}{L \times I}$$ (1 mark)

$$Vc = \frac{1000 \times 11.5}{20 \times 77}$$ (1 mark)

Vc = 7.468 m.V/A.m (1 mark)

[Reference: AS/NZS 3008 .2.1 TABLE 42]

SECTION C (Cont…)

Question 2. Answers: (10 marks)

2.1.a. The impedance of the fault path (Z) is:

$$Z_S = Zab + Zbc + Zcd + Zde + Zef$$

= 0.15Ω + 0.19Ω + 2.00Ω + 0.19Ω + 0.15Ω

= 2.68Ω (2 marks)

2.1.b. The magnitude of the fault current is:

$$I_F = U_O I Z_S$$

230/2.68

85.8 A (2 marks)

2.1.c. $U_T = I_F \times Z_{PE}$

= 85.8×0.19

= 16.3V (2 marks)

2.2. The touch voltage will not rise because the breaker will trip on a specified time of 0.4 secs to operate when there is a fault. (2 marks)

2.3. The specified time is 0.4 sec but it can increase if the main-earth is faulty at the installation thus the fault current will return through the PEN to the source and the new time for the breaker to trip fall within the range of 0.4 and more. (2 marks)

This value of current is high enough to operate the 16A protection device but not necessarily within the prescribed time, particularly if the appliance is supplied through a socket outlet. Incidentally, a C-type circuit breaker needs 7.5 times its rated current (i.e. 120A) to trip within the prescribed time when a fault occurs. The breaker will trip quickly and, until it does, the touch voltage has not risen above 16.3V, well under the limits stipulated by Clauses 1.5.5.3(C) and 5.7.4.