



COLLEGE OF ENGINEERING, SCIENCE AND TECHNOLOGY

SCHOOL OF ELECTRICAL AND ELECTRONICS ENGINEERING

PROGRAMME: BACHELOR OF ENGINEERING (ELECTRICAL & RENEWABLE) YEAR 4 (BENG 4)

## EEE789 POWER UTILISATION AND SERVICES

### FINAL EXAMINATION SEMESTER 1, 2017

TOTAL MARKS: 100

No. of Pages: 5

**Duration: 3 hours**

DATE/TIME/ROOM – Refer to Timetable

#### INSTRUCTIONS TO CANDIDATES

1. You are allowed 10 minutes extra time during which you are not to write.
2. Begin each answer on a fresh new page and use both sides of the sheets.
3. Write your identification number on the top of each attached sheet.
4. Insert all written foolscaps, graph paper, drawing paper etc. in their correct sequence and secure with string provided.
5. For all sheets of paper in which has been done, cross it through and you must attach to your answer script.
6. Write clearly the number(s) of the question(s) attempted on the top of each sheet.
7. AS/NZS 3000 & AS/NZS 3008 Wiring standards are permitted
8. *There are FOUR (4) sections, ALL SECTIONS ARE COMPULSORY.*

**SECTION A****[25 Marks]**

1. Discuss Fiji's Electrical Supply Network. Emphasize on features such as generation, EHV Transmission Sub-stations, HV Distribution substations / Zonal Substations, voltage levels, Interconnection, reliability, and SCADA network. You may also use an illustration to discuss this. **[4 marks]**

2. Elaborate on three types of Earthing Systems recognized by IEC. Furthermore, the Earthing system specified in AS/NZ 3000:2007 Wiring Rules is the Multiple Earthed Neutral (MEN) system. For a MEN System, illustrate and label the earthing terminologies. **[4 marks]**

3. A 3 phase 4 wire distribution system carries the following unbalanced loads:

Red Phase	45.0A at 10° lagging
White Phase	87.5A at 42° lagging
Blue Phase	62.5A at 27° lagging

Determine the current in the neutral wire. **[7 marks]**

4. A factory complex is supplied directly form a supply transformer. Estimate the prospective fault current at the main switchboard given:

- *Transformer rating: 300kVA 11kV / 415 V with an impedance of 3%*
- *Consumer mains: 4 x 300 mm<sup>2</sup> V90 four core cables installed in underground duct and route length of 15m. Assume  $\cos \phi = 0.25$ .* **[10 marks]**

**SECTION B****[25 Marks]**

1. Discuss the general rule for overcurrent protection to ensure sizing of a protection device. **[3 marks]**
2. Explain the operating mechanism of a RCD. **[2 marks]**
3. Comment on the essence of CTs and VTs in a power system, providing symbols and precautions to be taken. **[3 marks]**
4. Differentiate Electro-mechanical and Electronic meters. Discuss the features of a polyphase meter. **[3 marks]**
5. Discuss the features of MCB, MCCB and ACB. **[3 marks]**
6. Elaborate on limitation and calculation methods of estimating Maximum Demand. **[3 marks]**
7. For a 415V 3 Phase installation below, determine the maximum demand of the heaviest loaded phase in a domestic electrical installation comprising-
  - *45 lighting points*
  - *1 x 4000W Netball court lighting*
  - *30 x 10A Single-phase single socket outlets*
  - *10 x 10A double socket outlets*
  - *2 x 15A socket outlets*
  - *1 x 9000W 3-phase electric range*
  - *1 x 4000W Single phase AC*
  - *1 x 12000W 3-Phase instantaneous water heater*
  - *1 x 5000W Single phase clothes dryer*(Clearly state the load groups, the allocation of loads in each phase and finally maintaining a balance in the overall installation) **[8 marks]**

## SECTION C

[25 Marks]

1. Determine the maximum demand for the heaviest loaded phase of a rehabilitation hospital supplied by three phase with the following load:

- 62 x 20W compact fluorescent downlights rated at 0.16A each
- 54 x twin 28W fluorescent troffer luminaires rated at 0.30A each
- 7 x 400W Floodlights
- 188 x 10A socket outlets
- 5 x 15A socket outlets
- 1 x 20A socket outlets
- 1 x 13.6kW range (arranged for connection across two phases)
- 1 x 4.0kW food warmer
- 2 x 5.5kW lift motors rated at 10.2 A per phase
- 1 x 4.0kW hydrotheraphy pool pump rated at 8.5A per phase
- 2 x 10.4kW ducted air conditioning units each rated at 20A per phase

[8 marks]

2. Discuss the 3 methods listed in accordance with AS/NZS 3008.1 as part of cable selection procedure.

[3 marks]

3. For a single domestic dwelling, the maximum demand was calculated as 77A. The consumer's mains are to be single core V75 thermoplastic sheathed (TPS) stranded copper cables installed in heavy duty PVC conduit underground. Determine the minimum conductor size for consumer's mains using current carrying capacity method.

[3 marks]

4. The multiphase consumer's mains supplying a manufacturing premises are to be V90 insulated multi-core cables installed in heavy duty PVC conduit underground. The maximum demand for each phase was determined as 185A, 190A and 195A, respectively. The minimum current carrying capacity for all cables is equal to that of the highest phase, i.e. blue phase at 225A. There are two sets of multi-core cables touching part of their length placed in the same underground conduit. Determine the minimum conductor size for consumer's mains using current carrying capacity method. [4 marks]

5. A circuit wiring has the following information: (Please utilize the tables in the cable sizing standards)

*Consumer Mains:*

<i>Length</i>	-	<i>25m</i>
<i>Current</i>	-	<i>120A</i>
<i>Cable</i>	-	<i>35 mm<sup>2</sup> 4 core (buried and enclosed in conduits)</i>

*Submains:*

<i>Length</i>	-	<i>22m</i>
<i>Current</i>	-	<i>90A</i>
<i>Cable</i>	-	<i>25 mm<sup>2</sup> 4core + E (wired in conduits)</i>

*Final Subcircuit:*    *Length*        - 20m  
                          *Current*        - 30A  
                          *Cable*         - 4 mm<sup>2</sup> 2 core + E (unenclosed)

- i) If the supply is three phase 415/240 volts, calculate the voltage drop over the route length of the circuit.
- ii) State if the voltage drop is in accordance with the standards.
- iii) If the answer is NO in part (b) above, show with necessary calculations the changes required so that the voltage drop is within the rules. **[7 marks]**

**SECTION D** **[25 Marks]**

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1. Comment on any 3 factors affecting lighting design. **[3 marks]**
2. Explain the term Color rendering index. **[1 marks]**
3. Tabulate at least three types of interior or exterior lights and their applications. **[3 marks]**
4. A classroom of size 25m x 12m having the mounting height of 2.5m (3.2m – 0.7m) is to be illuminated using suitable types of twin fluorescent lamps. Illumination level required is 250 lux. Consider lumen output of each lamp as 2500 lumens. Take utilization factor as 0.8 and maintenance factor of 0.75, Consider  $SHR_{max} = 1.5$ . Calculate:
  - i) Number of twin type luminaires required, showing all steps clearly (test all space conditions)
  - ii) Draw a sketch of lighting arrangement showing all distances clearly. **[6 marks]**
5. Explain the operating principle and major components of the following:
  - i) Refrigerator
  - ii) Air-conditioner **[4 marks]**
6. Discuss the Preliminary Energy Audit Methodology. **[3 marks]**
7. State your views on the essence of energy management to a large commercial installation. **[2 marks]**
8. Highlight ways of reducing electricity bills or making industrial environment (manufacturing factory) energy efficient. Discuss as to what changes could be brought in on existing plant/machinery/equipment to reduce energy usage. **[3 marks]**

**THE END**