



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, 2016

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 THREE (3) sections, ALL SECTIONS ARE COMPULSORY.*

1. 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. [5 marks]

2. A balanced delta connected load of impedance $16 + j12 \Omega$ /phase is connected to a three phase 415V supply. Find the line current, power factor, apparent power and true power drawn. [5 marks]

3. State the condition to determine the rating of protection device that would ensure overload protection in an installation. [3 marks]

4. Define the term "*Prospective Short Circuit Current*". [2 marks]

5. A factory complex is supplied directly from a supply transformer. Estimate the prospective fault current at the main switchboard given:
 - Transformer rating: 250kVA 11kV / 415 V with an impedance of 4%
 - Consumer mains: 4 x 240 mm² V75 four core cables installed in underground duct and route length of 15m. Assume $\cos \phi = 0.25$.[8 marks]

6. Explain the operating mechanism of a **thermal magnetic circuit breaker**. [2 marks]

7. Explain the operating mechanism of a **Residual Current Device**. [2 marks]

8. Explain the significance of "**CT Metering**" and also state one major precaution that need to be taken with CTs. [3 marks]

1. State any two factors on which Maximum Demand is dependent. [2 marks]
2. Discuss any two methods of estimating Maximum Demand. [3 marks]
3. Comment on the essence of finding maximum demand. How is it useful? [2 marks]
4. Define Domestic and Non-Domestic installation. State examples. [3 marks]
5. 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 3500W Netball court lighting
- 30 x 10A Single-phase single socket outlets
- 10 x 10A double socket outlets
- 2 x 15A socket outlets
- 1 x 12kW 3-phase electric range
- 1 x 4000W Single phase AC
- 1 x 6000W 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) [10 marks]

6. A three phase sub-main supplies the distribution board in the processing area of a manufacturing complex. Determine the maximum demand for the sub-main given the following loads and allowing 30 % for future increase:

- 4 x twin 36W Fluorescent troffer luminaires each rated at 0.38A
- 16 x 400W Mercury Vapour high bay luminaires each rated at 2.28A
- 8 x 10A single phase socket outlets
- 4 x 15A Three phase socket outlets
- 2 x 20A Three phase socket outlets
- 1 x 63A Three phase socket outlets
- 1 x 12kW three phase induction heater
- 1 x 15kW motor rated at 27.1A per phase
- 3 x 7.5kW motor rated at 13.54A per phase
- 2 x 3.5kW motors rated at 6.48A per phase

[10 marks]

SECTION C**[40 Marks]**

1. Discuss the 3 methods listed in accordance with AS/NZS 3008.1 as part of cable selection procedure. **[3 marks]**

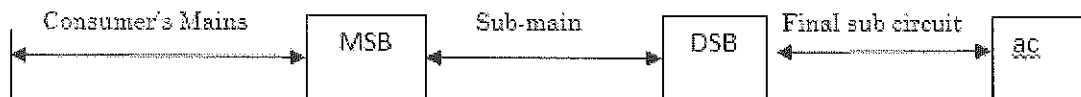
2. Define derating and rating factors. **[2 marks]**

3. A three-phase circuit is to supply a load of 400 A per phase. It is proposed to use TWO (2) sets V-75 insulated and sheathed four-core cables bunched together on a surface in a confined ceiling space where the ambient air temperature is 50°C.
Determine—
(a) the minimum conductor size; and
(b) the maximum route length of the circuit if a voltage drop of 3% is permitted on the circuit **[7 marks]**

4. A single phase final subcircuit is limited to a voltage drop of 8V due to the voltage drop in the consumers mains and submains. The circuit is wired in twin V75 thermoplastic-insulated TPS copper cable, unenclosed, to supply a 30A 240V factory load at a distance of 10m from the protective circuit breaker at the distribution board. What size cable should be selected? **[4 marks]**

5. A 3phase 415V Motor requires 32A, the desired route length is 30m, the minimum permissible voltage on the 3 phase circuit is 405V to ensure compliance with standards. The cables are to be V90 single core; wired in a conduit. What size cable is required? **[4 marks]**

6. A circuit wiring has the following information: (Please utilize the tables available for this question)



Consumer Mains: *Length* - 15 m
 Current - 115A
 Cable - 35 mm² 4 core (buried and enclosed in conduits)

Submains: *Length* - 30m
 Current - 90A
 Cable - 25 mm² 4core + E (wired in conduits)

Final Subcircuit: *Length* - 25m
 Current - 30A
 Cable - 4 mm² 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 AS/NZ wiring rules.
- 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]**
7. 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 300 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. **[5 marks]**
8. Explain the operating principle of a **Refrigerator**. **[3 marks]**
9. Define the term “**Energy Audit**”. **[2 marks]**
10. Highlight ways of reducing electricity bills of a manufacturing factory. Discuss as to what changes could be brought in on existing plant/machinery/equipment to reduce energy usage. **[3 marks]**

THE END