FIJI NATIONAL UNIVERSITY

COLLEGE OF ENGINEERING, SCIENCE AND TECHNOLOGY

SCHOOL OF ELECTRICAL AND ELECTRONICS ENGINEERING

B.E. (HONORS) (ELECTRICAL ENGINEERING) PROGRAMME, (BENG 4)

EEB 811 POWER UTILIZATION AND SERVICES

FINAL EXAMINATION (SEMESTER 1, 2019)

DATE/TIME/ROOM – Refer to Timetable

Total Marks – 100 Time Duration – 3 hours & 10 Minutes

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 rough work 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. *ANSWER ALL QUESTIONS.*

SECTION A — *25 MARKS*

1. Explain the basic difference between overvoltage and undervoltage in a system and discuss about the reasons for overvoltage and undervoltage conditions (at least one point). [4 Marks]

2. Discuss about the major difference between a low demand switchboard and a high demand switchboard. [3 Marks]

3. Explain about the instrument transformers and discuss about the needs for instrument transformers (at least two points). [5 Marks]

4. Fuse and residual current devices (RCD) are used for overcurrent protection in the system. Distinguish between Fuse and residual current devices (at least two points). [4 Marks]

5. Describe what is meant by the term "Maximum Demand" and list factors that should be considered when arranging an electrical installation into circuits (at least three points). [4 Marks]

6. Explain the term luminous efficacy and discuss about the prime objectives behind the design of a lighting system (at least two points). [4 Marks]

SECTION B — *75 MARKS*

1. Determine the line current, neutral current and total active power in an unbalanced star connected load supplied from a symmetrical three-phase, 440 V supply system. The branch impedance of the load are $Z_R = 5\angle 30^0\ \Omega$, $Z_W = 10\angle 45^0\ \Omega$ and $Z_B = 10\angle 60^0\ \Omega$. The phase sequence is RWB. [7 Marks]

2. A single phase final subcircuit is limited to a voltage drop of 6V due to a voltage drop in the consumer mains and submains. The circuit is wired in twin V75 thermoplastic-insulated TPS copper cable, unenclosed, to supply a 30 A, 230V factor load at a distance of 8 m from the protective circuit breaker at the distribution board. What size cable should be selected? (using table 42 in AS/NZS 3008.1.1: 2009) [4 Marks]

3. A factory complex is supplied directly from a supply transformer. Estimate the prospective fault current at the main switch board given:
   - Transformer rating: 30 kVA, 415V/230 V with an impedance of 3%.
   - Consumer mains: 4 x 400 mm^2 V90 four core cables installed in underground duct and route length of 15 m. Assume $cos\ \theta = 0.25$ [10 Marks]
   (Using the table Resistance = 0.0656 Ω/km and Reactance = 0.0728 Ω/km)

4. Determine the maximum demand for a single phase 230 V installation comprises
   - 18 lights outlets
   - 20 socket outlets
   - 9 kW range (comprising 5kW hotplates and 4 kW oven)
   - 3.6 kW air conditioner
   - 4 x 300 W floodlights in swimming pool area

   [10 Marks]

5. In a workshop where a good lighting is required, a 500 lux light source is recommended. A lighting system is chosen where 2 x 100 W white fluorescent lamp fitting is to be used. Each lamp has efficacy of 80 lumens/watts. The working area is 0.5 m above the floor. If the total height of the workshop is 7 m then using inverse square law, calculate the height of the lamp from the working plane and the distance from ceiling. [4 Marks]

6. In a class room, where good lighting is required, a 500 lux light source is recommended. A lighting system is chosen where 4 x 40W white fluorescent lamp fittings are to be used. Each 40W lamp emits 2800lm. The fitting provide direct lighting. The room dimensions are: Length – 10m, Width – 7m, Height – 6m.
   The working area is 0.65m above the floor.
   The Utilization factor is 0.54 and the maintenance factor is 0.8.
   Using Zonal Cavity Method for Indoor Lighting, calculate the following:
   (i) Height of direct lighting (i.e. mounting height) [1 Mark]
   (ii) Room Index [1 Mark]
   (iii) Number of light fittings [1 Mark]
   (iv) Draw a suitable layout for the room. [6 Marks]

7. Calculate the overall size of the Air conditioning unit required for a room. [8 Marks]
   - Number of people in the room 3 [2 active – 1 sitting]
   - Height of building 2.5 m
   - 2 by 10 watts of lights present in the room
   - Window area is 1.5 m by 1.0 m [East] with blinds
   - Door area is 2.0 m by 0.6m
   - Normal flat ceiling (Insulated)
   - Normal floor (Carpeted)
   - Concrete walls
   - Room Length – 6m ; Width – 4m

8. A refrigerator takes 4000 J of heat energy from the cold reservoir at 270 K and pumps it to the hot reservoir at 300 K. Calculate
   (i) The coefficient of performance (COP) of the system. [1Mark]
   (ii) How much work is needed to accomplish this? [1Mark]
   (iii) The amount of energy transferred to hot reservoir. [1Mark]

9. In a typical rural installation where Residential Tariff is used, a kWh meter established 500 670 kWh. The previous monthly reading was 500 548 kWh. (# Refer to Table 1)
   (i) Calculate the cost of energy for the current month with government subsidy. [4 Marks]
   (ii) If the current monthly reading was 500 745 kWh, than what will be charge for that month without government subsidy. [4 Marks]

10. A motor takes a current of 10 A at 0.65 power factor lagging, from a 230 V, 50 Hz supply. What size of capacitor is required to improve the power factor to 0.85 lagging? [4 Marks]

11. A commercial business whose maximum demand for a month was 120 kW has normal energy reading of 2700 kWh and have a reactive energy reading of 1680 kVArh. Calculate the charge for the month. (# Refer to Table 1) [8 Marks]

[THE END]