FIJI NATIONAL UNIVERSITY

COLLEGE OF ENGINEERING, SCIENCE AND TECHNOLOGY
SCHOOL OF ELECTRICAL AND ELECTRONIC ENGINEERING

TRADE DIPLOMA IN ELECTRICAL ENGINEERING

EEE538 ELECTRICAL POWER UTILISATION

EXAMINATION (SEMESTER 2, 2015)

DATE/TIME/ROOM – Refer to Exam Timetable

INSTRUCTIONS TO CANDIDATES

1. You are allowed 10 minutes extra time for reading during which you are not to write.
2. Allocated time of writing is 3 hours.
3. Begin each answer on a fresh new page and use both sides of the sheets.
4. Write your identification number on the top of each attached sheet.
5. Insert all written foolscaps, graph paper, drawing paper, etc in their correct sequence and secure with string provided.
6. For all sheets of paper in which has been done, cross it through and you must attach to your answer script.
7. Write clearly the number(s) of the question(s) attempted on the top of each sheet.
8. Question distribution are as follows and are compulsory :

Question 1 – Tariffs	(16 marks)
Question 2 – Lighting	(21 marks)
Question 3 – Refrigeration Plant and Air Conditioning	(23 marks)
Question 4 – Electrical process Heating	(20 marks)
Question 5 – Energy Management	(20 marks)

9. Total mark allocated is 100.

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Question 1 – Tariffs (16 marks)

1.1 Discuss the mechanics of tariffs, specifically elaborate on the following points ; what are tariffs, how must its cost be determined, what is its objective and mention three of its characteristics.

(8 marks)

1.2 In a typical rural installation where schedule 2 Tariff (refer to Appendix A1.1) is used, a kWh meter established 519265 kWh. The previous quarterly reading was 338 269. Calculate the cost of energy for the current quarter.

(3 marks)

1.3 Suppose you are the Electrical Technician of a 10 storey office building. Upon data collected for the past 2 months the average data have shown as below :

Average Actual Power Factor	= 0.68
Average Power, P	= 30 kW

Calculate using your Capacitor Calculation Table (refer to Appendic A1.3), the kVAR rating of the necessary capacitor module required to improve the power factor to 0.97. What is your order reference number if you are choosing Motopol®. *(Refer to A1.3 Appendix)*

(5 marks)

Question 2 – Lighting (21 marks)

2.1 The three primary objectives behind lighting design are (a) Safety and comfort of occupants, (b) minimization of energy consumption and (c) colour rendering.

Discuss how you would apply these objectives in the design of a lighting system.

(6 marks)

2.2 A room has its size as 12m x 10m with a ceiling height of 3 m., has a design illumination of 500 lux on the working plane (0.85 metres above the floor). The utilization factor (UF) is 0.5 and the maintenance factor (MF) is 0.8. If the LDL output of each fitting is 2720 lumens, design by calculating the following using the lumen method:

(a) The number of light fitting required (4 marks)

(b) Draw the grid fitting layout and state spacing both in the x and y direction. (5 marks)

(c) Space/Mounting Height ratio both in the x and y direction (2 marks)

2.4 Re-create and complete the table below :

	Symbol	Unit
Luminous Flux		
Illuminance		
Luminious Intensity		
Luminance		

(4 marks)

Question 3 – Refrigeration Plant and Air Conditioning **(23 marks)**

3.1 Illustrate through drawing the basic refrigeration cycle. (5 marks)

3.2 Discuss how the cycle of refrigeration works. Explain in terms of the five basic components of evaporator, compressor, condenser, expansion valve and refrigerant.

(10 marks)

3.3 You are required to design a suitable air conditioning system size for a particular room. The following information is available. What is the required BTU size of air conditioning unit required? *(Note the basic cooling capacity required is 8750 Btu/h)*

- *Room dimension* - room length = 8m, room width = 5 m
- *Window size and positioning* - 1 x south-facing window area of $2m^2$
  (Extremely sunny) - 1 x north-facing window area of $2m^2$
- *Occupants* – 3 x persons (note 600BTU is allocated per person)
- *Kitchen Area* – working kitchen with stove (allow for 4000 Btu/h)

(8 marks)

Question 4 – Electrical Process Heating (20 marks)

4.1 Discuss the principle of dielectric heating for industrial purpose. State the basic operation, its typical power consumption and operating frequency ratings. Use diagram in your explanation.

(10 marks)

4.2 Discuss using circuit and waveforms the method of controlling resistance heating by thyristors using burst firing. State why this method is most suitable for power control.

(10 marks)

Question 5 – Energy Management (20 marks)

5.1 Discuss the concept of power sharing between corporate companies like the Fiji Sugar Corporation and the Fiji Electricity Authority. When do they share power? Do they have a common shared benefit? Explain.

(10 marks)

5.2 The average primary energy saving from CHP (Combined Heat and Power) in the United Kingdom in 2007 was around 18%. In light of this report, discuss what CHP is and the advantages and benefits of CHP system.

(10 marks)

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End

Appendix 1

A1.1

Schedule 2

The following are examples from a tariff scale using mainly block-type tariffs. All prices are in cents per kWh except where otherwise indicated. This schedule is typical of one large energy distributor's rates.

- *Domestic rate:*
  - Supply charge per quarter $14.80
  - All consumption 11.92
- *Institution rate:*
  - Supply charge per quarter $14.80
  - All consumption 11.92
- *General supply rate:*
  - Supply charge per quarter $17.50
  - First 7500 kWh per quarter 13.49
  - Next 150 000 kWh per quarter 12.65
  - Next 750 000 kWh per quarter 10.10
  - Balance of kWh per quarter 9.75
- *Industrial maximum demand rate:*
  - First 300 000 kWh per month 5.90
  - Balance of kWh per month 3.78
  - Demand charge per kW of maximum demand per month (minimum chargeable demand 500 kW)
  - —for the first 10 000 kW $12.30
  - —for each additional kW $11.20
- *Industrial (block) rate:*
  - Supply charge per quarter $17.50
  - First 7500 kWh per quarter 13.49
  - Next 150 000 kWh per quarter 12.65
  - Next 750 000 kWh per quarter 10.10
  - Balance of kWh per quarter 9.75
- *Rural rate:*
  - Supply charge per quarter $17.50
  - First 7500 kWh per quarter 13.49
  - Next 150 000 kWh per quarter 11.8
  - Balance of kWh per quarter 10.10
- *Storage heating rate:*
  - Controlled-load (off-peak) 4.75.

A1.2

Actual Power Factor	Target Power Factor										
	0.90	0.91	0.92	0.93	0.94	0.95	0.96	0.97	0.98	0.99	1.00
0.66	0.65	0.68	0.71	0.74	0.78	0.81	0.85	0.89	0.94	1.00	1.14
0.67	0.62	0.65	0.68	0.71	0.74	0.78	0.81	0.86	0.90	0.96	1.10
0.68	0.59	0.62	0.65	0.68	0.72	0.75	0.79	0.83	0.88	0.94	1.06
0.70	0.54	0.56	0.59	0.63	0.66	0.69	0.73	0.77	0.82	0.88	1.02
0.72	0.48	0.51	0.54	0.57	0.60	0.64	0.67	0.71	0.76	0.82	0.96
0.74	0.42	0.45	0.48	0.51	0.55	0.58	0.62	0.66	0.71	0.77	0.91
0.76	0.37	0.40	0.30	0.46	0.49	0.53	0.56	0.60	0.65	0.71	0.86
0.78	0.32	0.35	0.38	0.41	0.44	0.47	0.51	0.55	0.60	0.66	0.80
0.80	0.27	0.29	0.32	0.35	0.39	0.42	0.46	0.50	0.55	0.61	0.75
0.82	0.21	0.24	0.27	0.30	0.34	0.37	0.41	0.45	0.49	0.56	0.70
0.84	0.16	0.19	0.22	0.25	0.28	0.32	0.35	0.40	0.44	0.55	0.65
0.86	0.11	0.14	0.17	0.20	0.23	0.26	0.30	0.34	0.39	0.45	0.59
0.88	0.06	0.08	0.11	0.14	0.18	0.21	0.25	0.29	0.34	0.40	0.54
0.90		0.03	0.06	0.09	0.12	0.16	0.19	0.23	0.28	0.34	0.48
0.92				0.03	0.06	0.10	0.13	0.18	0.22	0.28	0.43
0.93					0.03	0.07	0.10	0.14	0.19	0.25	0.40
0.94						0.03	0.07	0.11	0.16	0.22	0.36
0.96								0.04	0.09	0.15	0.20
0.98										0.06	0.20

The required capacitor output may be calculated as follows:
- Select the factor k (matching point of actual and target power factor)
- Calculate the required capacitor rating with the formula:

A1.3

Reference	kvar @ 440V 50Hz	kvar @ 415V 50Hz	kvar @ 400V 50Hz	H (mm)	Dia (mm)
MSC-2.5/440	2.5	2.2	2.0	190	60
MSC-5.0/440	5.0	4.4	4.1	190	60
MSC-8.33/440	8.33	7.5	6.9	265	60
MSC-11.2/440	11.2	10.0	9.3	265	64
MSC-14.0/440	14.0	12.5	11.6	265	84
MSC-16.9/440	16.9	15.0	13.9	265	84
MSC-22.5/440	22.5	20.0	18.6	340	84
MSC-28.1/440	28.1	25.0	23.2	340	84