FIJI NATIONAL UNIVERSITY

COLLEGE OF ENGINEERING, SCIENCE & TECHNOLOGY

SCHOOL OF ELECRICAL AND ELECTRONIC ENGINEERING.

TRADE/DIPLOMA IN ELECTRICAL ENGINEERING (ELECTRICAL & RENEWABLE ENERGY)
STAGE 4 (C & D).

EEE538 - ELECTRICAL POWER UTILISATION.

FINAL EXAMINATION - SEMESTER II - 2013.

DAY/DATE: AS PER ETB TIME: AS PER ETB ROOM: AS PER ETB

INSTRUCTIONS TO STUDENTS:

1. You are allowed 10 minutes **EXTRA** as reading time during which you are **NOT** to write.
2. Begin each answer on a fresh page and use both sides of the sheet.
3. Write your candidate number at the top of each attached sheet.
4. Insert all written foolscap, graph paper, drawing paper, etc. in their correct sequence and secure with a piece of string
5. Write clearly the number(s) of the question(s) attempted on the top of each sheet.
6. Answers to all questions must be written in **INK** on the Answer Sheet provided.
7. No programmable calculators are allowed.
8. Answer all questions.

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Q1. The production of domestic and commercial quantities of electrical energy requires a high initial investment. This prompts the introduction of various tariffs.

(a) Discuss the two main objectives of tariff. (2 marks)

(b) Draw the meter arrangement to suitably measure a three-phase balanced load using single-phase meters. (5 marks)

(c) Identify 5 tariff types and briefly explain their features (10 marks)

Q2. In a typical rural installation where Schedule 2 Tariff (*Attachment 1)* is used, a kWh meter registered 718 800 kWh. The previous quarterly reading was 530 552 kWh. Calculate the cost of energy for the current quarter. (3 marks)

Q3. Define the following terms and state briefly how they can be made necessary in light engineering and calculations:

(a) Luminous Flux (2 marks)

(b) Illuminance (2 marks)

(c) Luminous Intensity (2 marks)

(d) Luminance (2 marks)

Q4. In a drawing office bench as shown, *(Attachment 02)*, where good lighting is required, an 1600 lux light source is recommended. A lighting system is selected where twin 80W white fluorescent lamp fittings are to be used. Each 40W lamp emits 8000 lm. The fittings provide direct lighting. The room dimensions are: Length – 25m, Width – 23m and Height – 9m.
The working area is 0.8m above the floor, the utilization factor, U is 0.64 and the maintenance factor, M is 1. Calculate the following:

(a) Height of direct lighting (2 marks)

(b) Room index, k (2 marks)

(c) Number of light fittings (2 marks)

(d) The illumination level when the lights have been collecting dust and the wall colours dirty (M = 0.37) (2 marks)

Q5. (a) Name the four main components of refrigeration system and describe their functions in the system operation (8 marks)

(b) Draw and label fully the basic diagram of the refrigeration process. (2 marks)

Q6. An air condition system is installed in a room. The particulars are as follows:

Room size = 8m x 8m x 6m
Before treatment of air: dry bulb temperature = 28° C
: relative humidity = 45%
Air Density = 1.25kg/m³
Enthalpy at 28° C = 60 kJ/kg
Enthalpy at 38° C = 81 kJ/kg
Air Charges/hour = 12

Note – If air (fan) removes or provides 0.81m³ of air per second, it has 1 Ton Air Conditioning

Calculate:

(a) Enthalpy change (2marks)

(b) Ton and kW of air conditioningto remove heat.

[Hint: To find Ton = (kW x 3413) / 12 000] (9 marks)

(c) Ton of air conditioning to provide air (6 marks)

Q7. With the aid of a diagram, explain the principle of Indirect Resistance Heating and list five advantages of it. (10 marks)

Q8. With the aid of a diagram, fully explain what the concept of Thyristor Burst Firing in the control of resistance heating. (10 marks)

Q9. (a) Discuss the features and operation of Halogen Lamps. (7 marks)

(b) State one application of Halogen lamps and an installation precaution. (2 marks)

Q10. A factory has an actual power factor of 0.78 lag which needs to be upgraded to 0.95 lag. The real power was measured to be 4500kW.

(a) Using the table shown, (*Attachment 3*), find out the required size of capacitor output in kVAr. (3 marks)

(b) Briefly discuss the affect of power factor in a supply system and the various equipments that causes low power factor. (5 marks)

Attachment 1

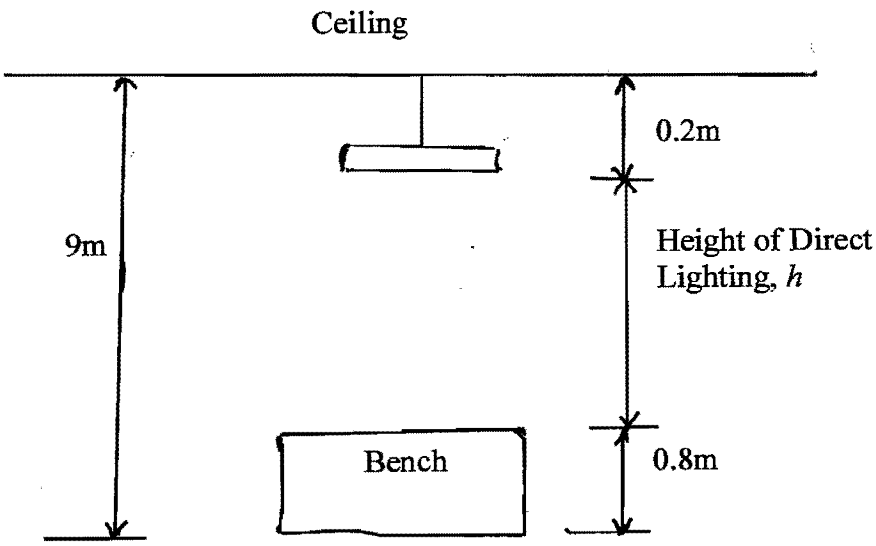
In reference to Question 2

Schedule 2
The following are example 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 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
  Balance charge per kW of maximum demand per month (minimum chargeable demand 500 kW).
  First 10000 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 11.80
  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 11.80
  Balance of kWh per quarter 10.10
- *Storing heating rate:*
  Controlled-load (off-peak) 4.75

Attachment 2

(a) Diagram in reference to Question 4



Attachment 3

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	0.62	0.65	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	1.08
0.70	0.54	0.58	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	0.48	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	0.26	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:
$Qc = k \times P$

Attachment 4

Useful Formulars

Illumination at an angle (peripheral), $E = I/D^2 \times \cos \Phi$

$C = (\varepsilon\ \varepsilon\ A)/d$

$E\ = (NFUM)/A$

Room Index = $\{(2 \times L) + (W \times 8)\}/(10 \times H)$

$Xc = 1/2\pi fC$

$P = V^2 (2\pi f)\{(\varepsilon_o\ \varepsilon_r A)/d\}\delta$

Loss Factor = $\varepsilon\ \delta$

kVAr required – $(\tan \theta 1 - \tan \theta 2) \times kW$