



FIJI NATIONAL UNIVERSITY

COLLEGE OF ENGINEERING, SCIENCE & TECHNOLOGY

SCHOOL OF ELECTRICAL & ELECTRONICS ENGINEERING

PROGRAMME: TRADE DIPLOMA IN ELECTRICAL ENGINEERING (ELECTRICAL & RENEWABLE) - STAGE 4

EEE538 ELECTRICAL POWER UTILISATION

FINAL EXAMINATION

Semester 2, 2016

Total Marks: 100

Total No. of Pages: 5

Duration: 2 hours and 10 minutes

DATE/TIME/ROOM – Refer to Timetable

INSTRUCTIONS TO CANDIDATES

1. You are allowed 10 minutes extra reading time during which you are NOT to write.
2. Begin each SECTION 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 foolscaps, graph paper, drawing paper, etc. in their correct sequence and secure with a string.
5. For all sheets of paper on which rough/draft work has been done, cross it through and ATTACH these to your answer scripts.
6. Write clearly the number(s) of the question(s) attempted on the top of each sheet.
7. *There are Four (4) sections, ALL SECTIONS ARE COMPULSORY.*

SECTION A:**Lighting****(25 marks)**

1. Differentiate between the “Conventional electromagnetic ballasts” and “Electronic Ballasts”. List down two [2] basic functions of electronic ballast. **(4 marks)**
2. Street lighting/ Public Lighting is one of the major electric loads in municipal areas. Number of street lights used in a Municipal area varies from 1000 to 50000 in numbers depending on the kilometers of road illuminated within the municipal limits. List down three controls that are adapted by Municipal council to reduce energy consumption in street lighting system. **(3 marks)**
3. In a class room, where good lighting is required, a 700 lux light source is recommended. A lighting system is chosen where 3 x 60W suspended white fluorescent lamp fittings are to be used. Each 60W lamp emits 3800lm. The fitting provide direct lighting. The room dimensions are: Length – 15m, Width – 8m, Height – 4m.
The working area is 650mm above the floor. Suspended height of the lamps is 0.5m.
The Utilisation factor is 0.54 and the maintenance factor is 30%.

Using Zonal Cavity Method for Indoor Lighting, calculate the following:

- a. Height of direct lighting **(2 marks)**
 - b. Room Index **(2 marks)**
 - c. Number of light fittings **(2 marks)**
 - d. The illumination level when the lights have been recently installed and all brand new. (maintenance factor $M= 1$) **(2 marks)**
4. Using a simple calculation elaborate on the **Inverse Square Law**. **(3 marks)**
 5. One of the energy saving opportunities in the lighting systems is “**Task Lighting**”. In your own words explain what do you understand by this. **(2 marks)**
 6. Explain the following basic parameters and terms in lighting system **(5 marks)**
 - a. Luminous Flux
 - b. Circuit Watts
 - c. Installed Load Efficacy
 - d. Color Rendering Index
 - e. Luminaire

SECTION B: AC and Refrigeration (25 marks)

1. Draw and explain the Refrigeration cycle. (7 marks)
2. List and further elaborate on any two types of Refrigeration System (4 marks)
3. List any two types of compressors and state its application (4 marks)
4. List down the 4 major components of an Air Conditioner and explain its function. (4 marks)
5. Calculate the overall size of the Air conditioning unit required for a room. [Attach AC Template provided with your answer booklet]. (6 marks)
 - Number of people in the room 3 [2 active – 1 sitting]
 - Height of building 2.5m
 - 4 by 10 watts of lights present in the room
 - Window area for each is 2.5m by 1.5m [East]
 - Door are is 2.0m by 0.6m
 - Normal flat ceiling
 - Normal floor
 - Concrete walls
 - Room Length – 5m ; Width – 4m

SECTION C: Tariff/Power Factor (25 marks)

1. A single phase 230V AC Generator delivers a power of 3kW. Calculate the current when:
 - a. The power factor is 0.5
 - b. The power factor is unity (4 marks)
2. What is “Power Factor” and list down four (4) effects of low power factor? (3 marks)
3. List and elaborate on any three characteristics of a Tariff. (6 marks)
4. In a Domestic installation where Residential Tariff is used, a kWh meter established 1011kWh. The previous monthly reading was 0916 kWh. (Refer to Table 1)
 - a. Calculate the cost of energy for the current billing month of 29 days (3 marks)
 - b. If the current monthly reading was 0813 kWh, than what will be charge for that month. (3 marks)

Residential Tariff	Tariff Rate – kWh Exclusive
Monthly usage =< 85 kWh – cents per kWh per month	17.20 cents
Monthly usage > 85 kWh – cents per kWh per month	33.1 cents

5. A table containing energy usage information for a small business company is given below:

Tariff Description	Reading Type	Meter Number	Reading		Usage	Billed Days
			Present	Previous		
Com Step 1	Normal Reading	50158977:1	00006735	00005685	1050	32
Reactive Units	Normal Reading	50158977:2	00003739	00003040	699	32

To assist you with the bill calculation, the following information is also given below

Units Consumed	Rate (cents)
Units up to 14,999kWh – cents per kWh per month	39.90cents
Units over 14,999kWh – cents per kWh per month	41.80 cents
Excess Reactive Energy – cents per kVarh per month	41.80 cents

Allowed Reactive Energy = $0.62 \times \text{Total kWh}$ (for the relevant billing period). Any reactive power which is used over this calculated 'Allowed Reactive Energy' figure is the 'Excess Reactive Energy' and is chargeable at a rate of \$0.4180 /kVarh. For the information provided above, calculate the bill for the small business company showing a step by step calculation and also taking VAT into account. (6 marks)

SECTION D: Heat Energy and Energy Management (25 marks)

1. Illustrate and explain the schematic diagram of a "Combined Heat and Power Plant" (CHP). (5 marks)
2. Illustrate and explain the principles of Induction Heating. (5 marks)
3. Resistance heating is based on the principle that, when a current is passed through an electrical resistor, electrical energy is converted to thermal energy. The thermal energy then is transferred to the part by convection, radiation and/or conduction. List down 4 advantages electric resistance heating. (4 marks)
4. A metal plate 1.5cm thick and 250cm^2 in area, having a relative permittivity of 2 and power factor of 0.1 is to be heated using dielectric heating. The power required is 500W and a frequency of 20MHz is used. Determine
 - a. The voltage required
 - b. The current flow through the material. (8 marks)
5. List down four [4] energy efficiency measures in Buildings for **Lighting System**.
6. Explain the term "Building Energy Management System (BEMS)". (3 marks)

-----THE END-----

ROOM AIR CONDITIONER HEAT LOAD ESTIMATE

STEP	HEAT SOURCE	"A" m ²	"B" Multiplying factor (Watts per square metre)				"C" Watts Cooling Load = "A" x "B"
			No Awnings, Curtains and Blinds	No Awnings Yes Curtains Yes Blinds	Yes Awnings, Curtains and Blinds	Fully Shaded eg. Patio, Carport	
1.	Area of Glass Window. Select the window which gives the largest value of A x B facing:						
	Window No 1.						
	South		120	95	65	60	
	Sth East or Sth West		380	260	130	60	
	East or West		430	300	145	60	
	North		270	190	100	60	
	Nth East or Nth West		370	260	130	60	
	Window No 2.						
	South		120	95	65	60	
	Sth East or Sth West		380	260	130	60	
	East or West		430	300	145	60	
	North		270	190	100	60	
	Nth East or Nth West		370	260	130	60	
	2.	Outside Wall Area less window					
Wall No. 1		Brick, brick veneer	Exposed to sun	35			
		Weatherboard, fibro	Exposed to sun	40			
		Brick, brick veneer weatherboard, fibro	Not exposed to sun	15			
Wall No. 2		Brick, brick veneer	Exposed to sun	35			
		Weatherboard, fibro	Exposed to sun	40			
		Brick, brick veneer weatherboard, fibro	Not exposed to sun	15			
Wall No. 3		Brick, brick veneer	Exposed to sun	35			
		Weatherboard, fibro	Exposed to sun	40			
		Brick, brick veneer Weatherboard, fibro	Not exposed to sun	15			
3.	Door Area		Closed when not in use		100		
4.	Internal Wall Area						
	Wall No. 1				8		
	Wall No. 2				8		
	Wall No. 3				8		
5.	Floor Area	Uncarpeted			12		
		Carpeted			6		
6.	Ceiling Area (same measurement as floor area)	Uninsulated			50		
		Insulated			8		
7.	Number of People Living in household	Sitting or Sleeping			120 per person		
		Active			250 per person		
8.	Lights and Appliances Eg. Television, Audio System, Fridge, lighting	Calculate total power in watts					
9.	SENSIBLE COOLING LOAD (WATTS)	TOTAL "C" =					
10.	Required Thermal Cooling Capacity	Sensible total x 1.3 + 1000 =					