The Open University of Sri Lanka -- 074

Faculty of Engineering Technology

Department of Electrical & Computer Engineering

Study Programme	: Bachelor of Science Honours in Engineering
Name of the Examination	: Final Examination
Course Code and Title	**: EEX4332 Electrical Power**
Academic Year	: 2022/2023
Date	: 11th February 2024
Time	: 0930-1230hrs

General Instructions

1. Read all instructions carefully before answering the questions.
2. This question paper consists of **Five (05)** questions in **Five (05)** pages.
3. Answer **all questions**, All the questions carry **equal marks**.
4. Answer for each question should commence from a new page.
5. Relevant figures and tables are provided with the question paper
6. This is a Closed Book Test **(CBT).**
7. Answers should be in clear hand writing.
8. Do not use red colour pen.

Question 01

a) Explain the importance of developing renewable energy sources for electricity generation in Sri Lanka **[4 marks]**

b) Figure Q1 shows how the power factor of an inductive load is improved using a shunt capacitor C1. The inductive load is represented with L1 and R1

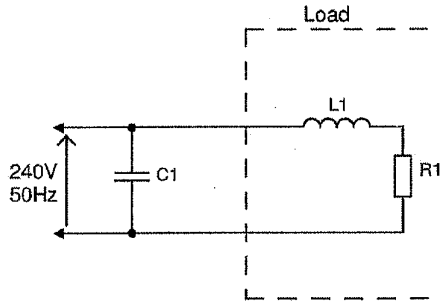


Figure Q1

If R1=4 Ω and L1=1000mH, calculate:

i. Complex impedance of the inductive load formed by L1 and R1. **[02 marks]**
ii. The power factor of the load before connecting the capacitor C1. **[04 marks]**
iii. The value of C1 required achieving a lagging power factor of 0.85 at the supply terminals. **[10 marks]**

Question 02

a) State what is meant by the term "electrical installation" **[2 marks]**

b) Consider a house which has 230 V, 50 Hz electrical supply from the CEB. In the house, there is a 15A socket outlet circuit protected by a 20A Type B MCB BS EN 60898. This socket outlet circuit has an internal resistance of 0.08Ω. The external earth fault loop impedance of the house is 0.6Ω. The house owner connects an electric oven to the circuit and that oven develops a ground fault which has an effective resistance of 1.8 Ω across the oven (the load). You can consider average body resistance of a human as 1500Ω. Calculate,

i. Prospective earth fault current flowing through the oven **[03 marks]**
ii. Prospective earth fault voltage across the oven **[03 marks]**
iii. The time taken for the MCB to blow **[03 marks]**
iv. Assume that the house owner accidently touch the metal part of the oven which has the ground fault by the time he switch on the oven. What type of contact the house owner is getting in this instance (Direct or Indirect)? What is the current that is flowing through his body? **[03 marks]**
v. What form of electric shock will the house owner would get? **[03 marks]**
vi. As per the BS 7671 IET Wiring regulation, What essential device is missing in this circuit? **[03 marks]**

Following graphs are available in the appendix at the end of this paper for you to refer and you are free to use any reasonable assumptions
Appendix 01 - MCB BS EN 60898 characteristics
Appendix 02- Time/Current zones characteristics (15 -100 Hz)

Question 03

a) Transformers play a pivotal role in electrical power systems, facilitating the efficient transmission and distribution of electrical energy. However, transformers are not perfectly efficient, and energy losses occur during their operation. Briefly explain about the different types of losses occurs in a power transformer. **[05 marks]**

b) Briefly explain how open circuit and short circuit tests are conducted to determine the equivalent circuit parameters of a transformer. **[04 marks]**

c) The Open circuit and Short circuit tests were conducted on 20 kVA, 50 Hz, 2000/20 V transformer and following results were obtained.

OC test: Primary Voltage 200V, Primary Current 4A, Power 120 W

SC test: Primary Voltage 60V, Primary Current 10A, Power 300 W

I. Calculate the equivalent circuit parameters of the transformer **[04 marks]**

II. Draw the equivalent circuit of the transformer referred to HV and LV sides respectively indicating all the calculated parameters. **[04 marks]**

III. Calculate the full load efficiency of the transformer at 0.85 lagging power factor. **[03 marks]**

Question 04

a) Brushless Direct Current Motor (BLDCM) is the latest addition to the family of DC motors. What is the major difference of BLDCM when compared with the conventional DC motor? What are the inherent advantages of BLDCM with regard to that difference? **[03 marks]**

b) Compare the main three types of stepper motors based on their construction principle. **[03 marks]**

c) Explain briefly, in your own words, why the rotor speed of an induction motor is naturally lower than the synchronous speed. **[03 marks]**

d) A 200V DC shunt motor takes 27 A at the rated voltage and runs at 800 r.p.m. Its field resistance and armature resistance are 100 Ω and 1 Ω respectively. If an additional resistance of 20 Ω is inserted in the armature circuit, compute the followings:

I.Motor speed and the line current when the load torque varies proportionally with the speed **[06 marks]**

II.Motor speed and the line current when the load torque varies proportionally with the square of the speed **[05 marks]**

Question 05

a) Ring distribution systems are often preferred over radial distribution systems due to several advantages. Briefly explain one of them. **[02 marks]**

b) A load variation throughout a day of a certain consumer metered at 11 kV, 50 Hz AC system is shown in Table Q5

Table Q5

Time Range	0000-0800 hrs	0080-1200 hrs	1200-1800 hrs	1800-2400 hrs
Type of the Load	Forty(40) Incandescent Lamps (250 W each)	Forty(40) Incandescent Lamps (250 W each) 10 kW Induction Motor (Operating at 0.9 power factor) Ten(10) Laser Printers * (Nominal power 500W each) at standby mode	Forty(40) Incandescent Lamps(250 W each) 6 kW Induction Motor (Operating at 0.95 power factor) Ten(10) Laser Printers *(Nominal power 500W each) at printing mode	Forty(40) Incandescent Lamps (250W each) Hundred (100) Fluorescent Lamps with magnetic ballast (16 W each with 0.8 power factor)

*Power factor of the given laser printers can be assumed as unity during the printing mode and during the standby mode power consumption is 50W at 0.6 power factor.

i. Draw the daily load curve for this consumer. **[03 marks]**

ii. What is the maximum kVA demand? **[08 marks]**

iii. What is the applicable tariff rate for this consumer? **[02 marks]**

iv. Calculate the monthly electricity bill of this consumer. **[05 marks]**

Note: A month consists of 30 days. Tariff rates offered by the Particular electricity company is given is given in the next page.

Tariff Rates of the mentioned electricity company

Customer Category I- 1

This rate shall apply to supplies at each individual point of supply delivered and metered at 400/230 Volt nominal and where the contract demand is less than or equal to 42 kVA.

Customer Category I- 2

This rate shall apply to supplies at each individual point of supply delivered and metered at 400/230 Volt nominal and where the contract demand exceeds 42 kVA.

Customer Category I- 3

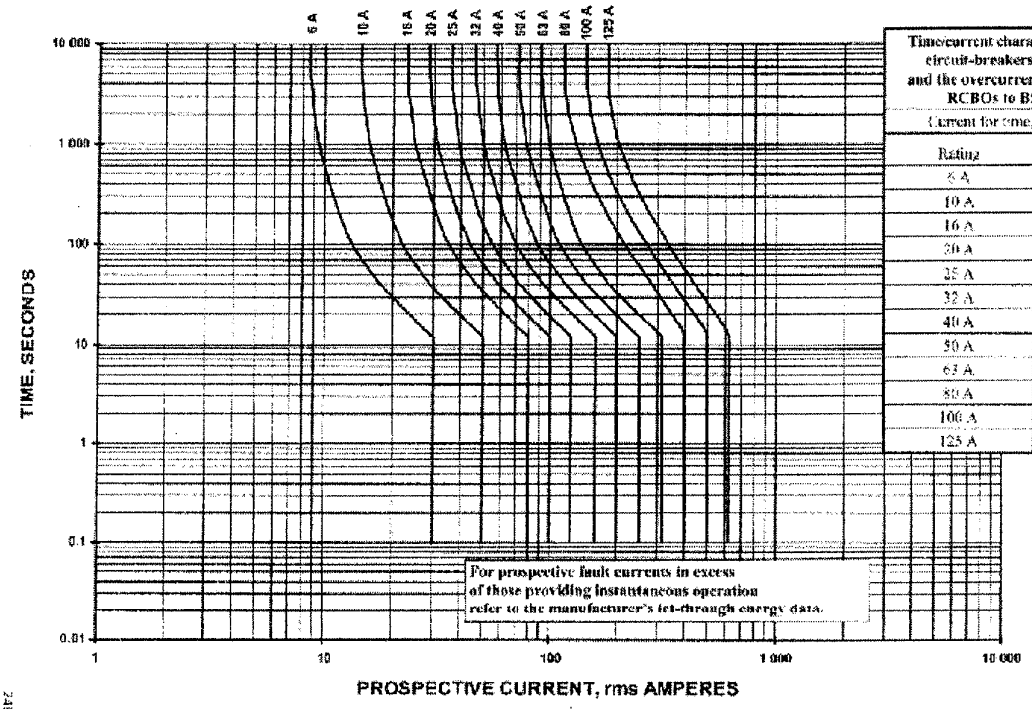
This rate shall apply to supplies at each individual point of supply delivered and metered at 11,000 Volt nominal and above.

Customer Category	Energy charge (LKR/kWh)			Fixed Charge (LKR/ month)	Maximum Demand Charge per month (LKR /kVA)	Fuel adjustment charge (% of Energy Charge)
	Peak (1830hr-2230hr)	Off-Peak (2230hr-0530hr)	Day (0530hr-1830hr)			
Industry						
I-1	12.50			600		15
I-2	21.00	7.00	11.30	3,000	1,100	15
I-3	24.00	6.00	10.50	3,000	1,000	15
Street Lighting	17.00			None	None	0

Note: Fuel adjustments charge is applied only on monthly energy charge. It is not applied on monthly fixed charge and monthly demand charge.

Appendix 01

Fig 3.4 Type B circuit-breakers to BS EN 60898 and RCBOs to BS EN 61009-1



Timecurrent characteristics for Type B circuit-breakers to BS EN 60898 and the overcurrent characteristics of RCBOs to BS EN 61009-1	
Current for time, 0.1 sec to 5 secs	
Rating	Current
6 A	30 A
10 A	50 A
16 A	80 A
20 A	100 A
25 A	125 A
32 A	160 A
40 A	200 A
50 A	250 A
63 A	315 A
80 A	400 A
100 A	500 A
125 A	625 A

Appendix 02

