# The Open University of Sri Lanka
## Faculty of Engineering Technology
### Department of Electrical and 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 | : | 2024/25 |
| Date | : | 25th February 2026 |
| Time | : | 0930-1230h |
| Duration | : | 3 hours |

**General instructions**

1. Read all instructions carefully before answering the questions.
2. This question paper consists of **Five (5)** questions in **Five (5)** pages.
3. Answer **all** questions.
4. All questions carry equal marks.
5. Answer for each question should commence from a new page.
6. This is a Closed Book Test (CBT).

**Question 01**

a. Why is it necessary to use high voltages for electricity transmission from a technical and economic standpoint? (04 marks)

b. A load variation through-out a day of a certain Industrial consumer metered at 400/230 kV, 50Hz is shown in Table 01

***Table 01***

| Time (hrs) | Load description |
|---|---|
| 0000-0700 | • 50 Incandescent bulbs- each 200 W<br>• 120 Fluorescent tubes- each 100 W (0.6 power factor-each 100W) |
| 0700-1200 | • 50 Incandescent bulbs- each 200 W<br>• 120 Fluorescent tubes- each 100 W (0.6 power factor-each 100W)<br>• 2 Induction motors operating at 0.8 power factor-each 8 kW |
| 1200-1800 | • 50 Incandescent bulbs- each 200 W<br>• 120 Fluorescent tubes- each 100 W (0.6 power factor-each 100W)<br>• 3 Induction motors operating at 0.95 power factor- each 6 kW |
| 1800-2400 | • 50 Incandescent bulbs- each 200 W<br>• 120 Fluorescent tubes- each 100 W (0.6 power factor-each 100W) |

i. Draw the daily load curve and determine the load factor of the above consumer. (03 marks)

ii. Calculate maximum demand? (02 marks)

iii. Select suitable tariff structure for this consumer (refer the Table 02 given in appendix) and give reason for your answer. (02 marks)

iv. Determine the monthly electricity bill of this consumer. (05 marks)

v. Calculate the size of the capacitance/phase need to be installed between 0700-1200 h to improve the power factor to 0.95. Capacitors are delta connected. (04 marks)

Note: A month consists of 30 days

Tariff rates offered from Ceylon Electricity Board is given in Appendix (page 05)

**Question 02**

a. Why is the single phase induction motor not self-starting? (02 marks)

b. A 18.65 kW, 4 pole, 50 Hz, 3-phase induction motor has friction and windage losses of 2.5 percent of the output. Full load slip is 4 %. For the full load find followings:

i. Rotor copper loss (02 marks)

ii. Rotor input power (01 marks)

iii. Shaft torque (04 marks)

iv. Gross electromagnetic torque (03 marks)

c. The real power input to a 415 V, 50 Hz, 6 pole, 3-phase induction motor running at 970 rpm is 41 kW. The power factor is 0.9. The stator losses amount to 1.1 kW, and total mechanical losses is 1.2 kW.

Calculate:

i. Line current (01 marks)

ii. Slip (02 marks)

iii. Rotor copper loss (02 marks)

iv. Mechanical power (01 marks)

v. Output Power (01 marks)

vi. Efficiency (01 marks)

**Question 03**

a. Why an auto-transformer is not used as a distribution transformer? (02 marks)

b. A 10 kVA, 230/110 V transformer is to be used as an auto-transformer. If the output voltage is 110 V, determine voltage ratio and output rating of this autotransformer. (06 marks)

c. Explain the reason for short circuiting the low voltage side of a power transformer during short circuit test. (02 marks)

d. Following readings are obtained from open-circuit and short-circuit tests on 10 kVA, 450/120 V, 50 Hz single-phase transformer:

O.C test: V1=120 V, I1=4.2 A, W1=100W (read on the low voltage side)

S.C test: V1=10 V, I1=22 A, W1=140W (with low voltage winding short circuited)

calculate:

i. The equivalent circuit parameters (04 marks)

ii. Full load efficiency and voltage regulation at 0.8 lagging power factor (04 marks)

iii. The efficiency at half full-load at 0.8 lagging power factor (02 marks)

**Question 04**

a. Why is the DC Series Motor never started on No-Load? (04 marks)

b. Draw the below characteristics curves of DC Series motor

i. Torque- Armature current characteristics (02 marks)

ii. Speed-Armature current characteristics (02 marks)

iii. Speed-Torque characteristics (02 marks)

c. A 220 V, 7.5 kW series motor is mechanically coupled to a fan. When running at 400 rpm, the motor draws 30 A from the mains (220 A). The torque required by the fan is proportional to the squares of speed. Armature resistance $R_a$= 0.6 Ω, series field winding resistance $R_{se}$ = 0.4Ω. Neglect armature reaction and rotational losses. Also, assume that the magnetization characteristics of the motor to be linear.

i. Determine the power delivered to the fan and torque developed by the motor. (05 Marks)

ii. Calculate the external resistance to be added in series to the armature circuit to reduce the fan speed to 200 r.p.m. (05 marks)

**Question 05**

a. Briefly explain the term "Harmonics" in power systems and what are the causes (minimum 04 Causes) for power system harmonics? (03 marks)

b. Consider the circuit shown in figure Q5.

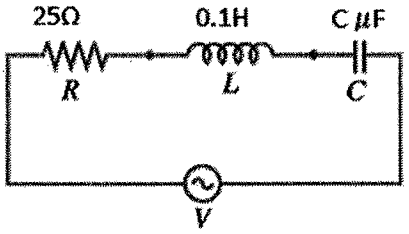



Figure Q5.

The instantaneous value of voltage applied across the circuit is given by,

$v(t)= 100\text{Sin}(\omega t) + 20\text{Sin}(3\omega t +45^0) + 5\text{Sin}(5\omega t +30^0)$ V

Where: $\omega = 314$ rad/s

i. Determine the value of 'C' which will produce resonance at the 3rd harmonic frequency. (03 marks)

ii. Using the value C obtained in (i), find

- An expression for the current flowing through the circuit. (10 marks)
- The r.m.s value of this current (02 Marks)
- The total power dissipation of the circuit (02 marks)

## Appendix

## Tariff rates offered from the utility for Question 1

**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.

Table 02

| 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 | Consumption/month <301- 10.80<br>Consumption/month >300- 12.20 | | | 600 | | 0 |
| I-2 | 20.50 | 6.85 | 11.00 | 3000 | 1100 | 0 |
| I-3 | 23.50 | 5.90 | 10.25 | 3000 | 1000 | 0 |

*All Rights Reserved*