The Open University of Sri Lanka
Faculty of Engineering Technology
Department of Electrical and Computer Engineering

Study Programme	: Bachelor of Technology Honours in Engineering
Name of the Examination	: Final Examination
Course Code and Title	**: EEX4332 -Electrical Power**
Academic Year	: 2019/20
Date	: 28th July 2020
Time	: 0930-1230 hrs
Duration	: **3 hours**

General Instructions

1. Read all instructions carefully before answering the questions.
2. This question paper consists of **Eight (8)** questions in **Six (6)** pages.
3. Answer any **Five (5)** questions only. All questions carry equal marks.
4. Answer for each question should commence from a new page.
5. Relevant charts/ codes are provided.
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 difference between a base-load and a peak-load generating plant. **[02 Marks]**

b) Figure Q1 shows a typical demand pattern (chronological curve) of an electric utility system segregated into base, intermediate and peak load sections. Briefly explain the appropriate type of generating plants used for each section. **[06 Marks]**

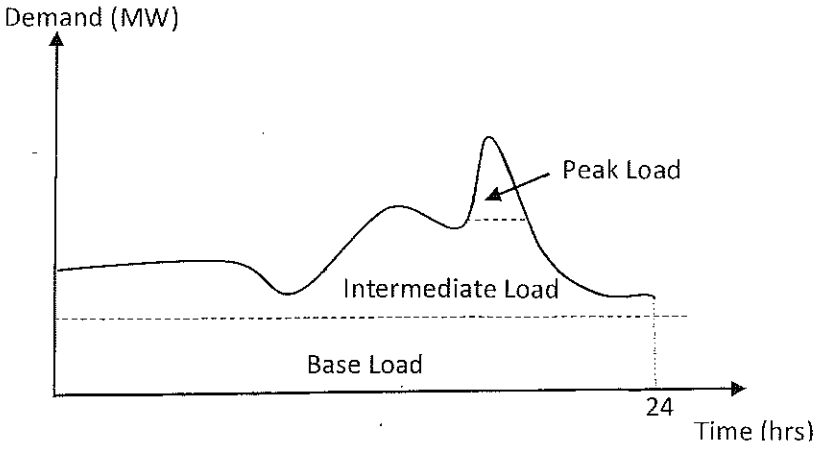


Figure Q1

c) Consumer owns a warehouse metered at 50 Hz, 400/230V; provides its service through-out the day. It has several electrical equipment's connected during given time intervals as shown in Table Q1.

Table Q1

Time (hrs.)	Description of the Load
0000-0600	• 100 Incandescent bulbs- each 100 W • 200 Fluorescent tubes- each 60 W
0600-1000	• 200 Fluorescent tubes- each 60 W • 2 Induction motors operating at 0.8 power factor- each 8 kW • 1 DC servo motor - 4 kW
1000-1200	• 200 Fluorescent tubes- each 60 W • 3 Induction motors operating at 0.8 power factor-each 8 kW • 3 DC servo motors - each 4 kW
1200-1800	• 60 W Fluorescent tubes -200 • 4 Induction motors operating at 0.95 power factor- each 6 kW • 2 DC servo motors – each 4 kW
1800-2400	• 100 Incandescent bulbs- each 100 W • 200 Fluorescent tubes- each 60 W

i. Draw the daily load curve and determine the load factor of the above consumer.
ii. What is the maximum demand?
iii. What is the applicable tariff structure for this consumer?
iv. Determine the monthly electricity bill of this consumer.
v. Calculate the size of the capacitance/phase needed to be installed between 1200-1800 hrs. to improve the warehouse power factor to unity. Capacitors are star connected

Note: A month consist of 30 days. Tariff rates offered from the utility is given in page 6

[12 Marks]

Question 02

a) Explain how a voltage is induced in the secondary winding of the transformer. **[3 Marks]**

b) Compare merits and demerits of an auto transformer and a two-winding transformer **[5 Marks]**

c) An open circuit (OC) test and a short circuit (SC) test are conducted on a single-phase distribution transformer rated at 10 kVA, 450/120 V, 50 Hz. The following results were obtained from the two tests:

OC test: 120 V, 4.2 A, 80 W

SC test: 9.7 V, 22.2 A, 120 W

i. draw the equivalent circuit of the transformer referred to LV side with indicating all the parameters.
ii. calculate the full load efficiency of the transformer at 0.8 lagging power factor
iii. determine the load at maximum efficiency
iv. determine the maximum efficiency of the transformer at 0.8 lagging power factor
v. determine the percentage voltage regulation **[12 Marks]**

Question 03

a) What is the latest IEE wiring regulations applicable to Sri Lanka? Briefly explain the difference of previous regulation and new regulation? **[4 Marks]**

b) Explain the terms "ELCB" and "RCCB" used in electrical installation. What is the significant difference between them? **[4 Marks]**

c) Chapter 13 of the IET regulations give the fundamental Principles. Discuss three important regulation under this fundamental principle. **[4 Marks]**

d) What are the protective measures stated in direct contact and indirect contact with respect to IET wiring regulations? **[4 Marks]**

e) Briefly explain the parameters which affects the degree of danger in case of an electric shock for a human being. **[4 Marks]**

Question 04

a) Figure Q4 shows the characteristics curves of a DC generator. Identify type of the generator. **[2 Marks]**

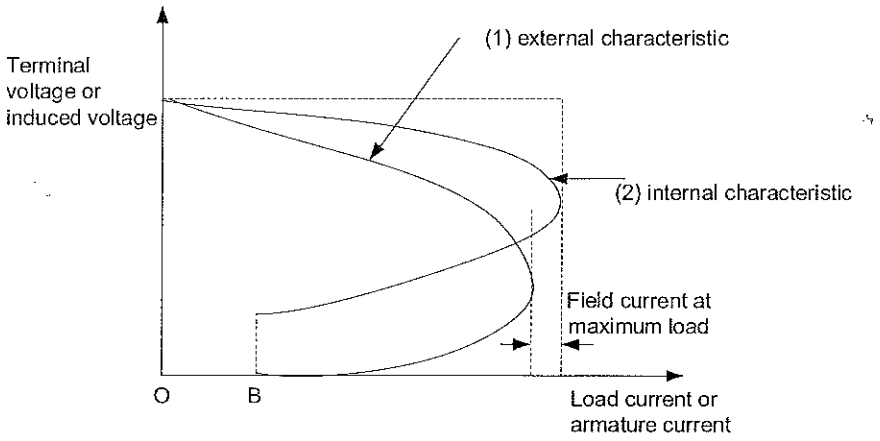


Figure Q4

b) Using figure Q4, explain what happens to the generator mentioned in part a) during an accidental short circuit. **[3 Marks]**

c) A 4 pole DC series motor has wave connected winding with 600 conductors. Total resistance of the motor is 0.8 Ω. When fed from 250 V DC source, the motor supplies a load of 10 kW and takes 50 A with a flux per pole of 3 mWb. For these operating conditions, calculate the developed torque and shaft torque. **[6Marks]**

d) A DC shunt machine, when run as a motor on no load takes 460 W at 230 V and runs at 1000 rpm. The field current and armature resistance are 1 A and 0.5 Ω respectively. Calculate the efficiency of the machine when running as a generator delivering 40 A at 230 V. **[9 Marks]**

Question 05

a) Explain the working principle of three-phase induction motor. Explain why the rotor of an induction motor cannot run at synchronous speed? **[4 Marks]**

b) A 10 kW, 400 V, 4 pole, 50 Hz delta connected three-phase induction motor is running at no load with a line current of 8 A and an input power of 660 W. At full-load, the line current is 18 A and the input power is 11.2 kW. Stator effective resistance per phase is 1.2 Ω and friction and windage loss is 420 W. For negligible rotor ohmic loss at no load, calculate:

i. Stator core loss
ii. Total rotor losses at full load
iii. Total rotor ohmic losses at full load
iv. Full-load slip
v. Internal torque and shaft torque
vi. Motor efficiency **[16 Marks]**

Question 06

a) Compare merits and demerits of "Brushless DC motor" with "Brushed DC motor".**[2 Marks]**

b) Figure Q6 shows the control block diagram of a Brushless DC motor. Name the blocks represented by A, B, C, D, E and signals represented by S1, S2, S3. Briefly explain the operation of each block. **[6 Marks]**

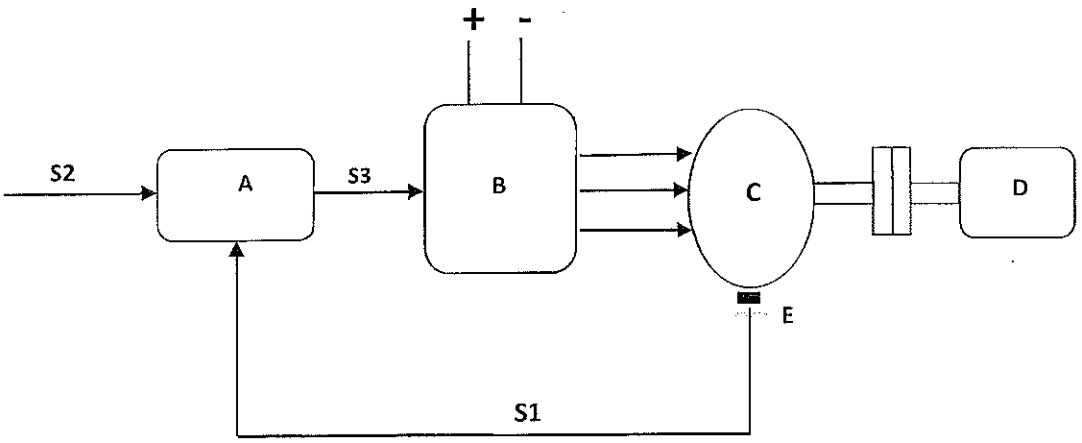


Figure Q6

c) What is the difference between a variable reluctance and a permanent magnet stepper motor? **[4 Marks]**

d) Give sketches to show the construction of 6/4 pole, three-phase variable reluctance stepper motor. Determine the basic step angle and indicate switching pattern for normal stepping and half-stepping operations. **[4 Marks]**

e) Draw a typical speed-torque curve for a stepper motor. Why a stepper motor develop a larger torque when it is slewing than when it is operating in the start-stop region. **[4 Marks]**

Question 07

a. Explain the term "Harmonics" in power systems and what are the causes for power system harmonics? **[5 Marks]**

b. A distorted voltage is represented by the following equation(angles expressed in degrees, t in seconds);

$$E = 850 \sin 18000t + 340 \sin(126000t - 30°)$$

Calculate,

i. The frequency of the fundamental and the harmonics

ii. The effective value of the fundamental and the harmonics

iii. The effective value of the distorted voltage

iv. The instantaneous voltage when t=1 ms.

v. Draw the phasor diagram that represents the distorted voltage and sketch its waveshape

[15 Marks]

Question 08

a) Discuss following topics briefly

i. Current situation of nuclear energy generation (feasibility/problems identified and possible solutions) related to Sri Lankan power sector

ii. Renewable energy integration to the existing power distribution grid- (problems and possible solutions) **[8 Marks]**

b) Explain the reasons to use high voltages in electricity transmission network. Also discuss the other technical and economic factors that affect the transmission voltage levels **[4 Marks]**

c) Briefly discuss the factors to be considered when selecting a motor drive for particular application **[4 Marks]**

d) What are the possible solutions to reduce peak demand in Sri Lanka? Explain with examples.

[4 Marks

Tariff rates offered from the utility for Q#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.

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.