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	**: EEX3532/ECX3232 -Electrical Power**
Academic Year	: 2017/18
Date	: 08th February 2019
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 **Five (5)** 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) Briefly describe the economic and technical factors which are directly involved in deciding electricity transmission and distribution voltage levels **[05 Marks]**

b) What are the voltage levels used in Sri Lankan electricity transmission and distribution network? Explain which type of transformers are used in each voltage level **[03 Marks]**

c) A load variation through-out a day of a certain consumer metered at 400/230 kV, 50 Hz is shown in Table Q1

Table Q1

Time (hours)	0000-0600	0600-1300	1300-1800	1800-2400
Total Load (kW)	25	40	43	25
Load Description	Lighting Load only	Lighting Load +	Lighting Load +	Lighting Load only
		15 kW induction motor load operating at 0.85 p.f	18 kW induction motor load operating at 0.9 p.f.	

    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 need to be installed between 0600-1300 hrs to improve the 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 5 **[12 Marks]**

Question 02

a) A single phase transformer delivers power to an inductive load. Draw a phosor diagram for the transformer at full load situation. Assume transformer has impedances on its windings.

[6 Marks]

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b) An open circuit (OC) test and short circuit (SC) test are conducted on a single phase transformer rated at 5 kVA, 200/1000 V, 50 Hz. The following results were obtained from the two tests.

SC test:	V= 50 V	I= 5 A	P=110W
OC test:	V=200V	I=1.2 A	P= 90 W

    i.   Calculate the value of the reactance and resistance of the transformer, refereed to the LV side

    ii.   Calculate the the values of magnetizing reactance (X_m) and core loss resistance (R_C) on the LV side

    iii.   Draw the equivalent circuit of the transformer referred to LV side

    iv.   Determine the output secondary voltage when it delivering a load of 3 kW at 0.8 lagging power factor.

    v.   Determine the percentage voltage regulation   **[14 Marks]**

Question 03

a) Explain the terms "ELCB" and "RCCB" used in electrical installation. What is the main difference between them? Which one you recommend to use in Sri Lanka.   **[4 Marks]**

b) Figure Q3 shows two different types of electric shock. What are the protective measures need to be used to protect from each shock separately. Also explain their limitations.

[4 Marks]

DIRECT CONTACT   INDIRECT CONTACT

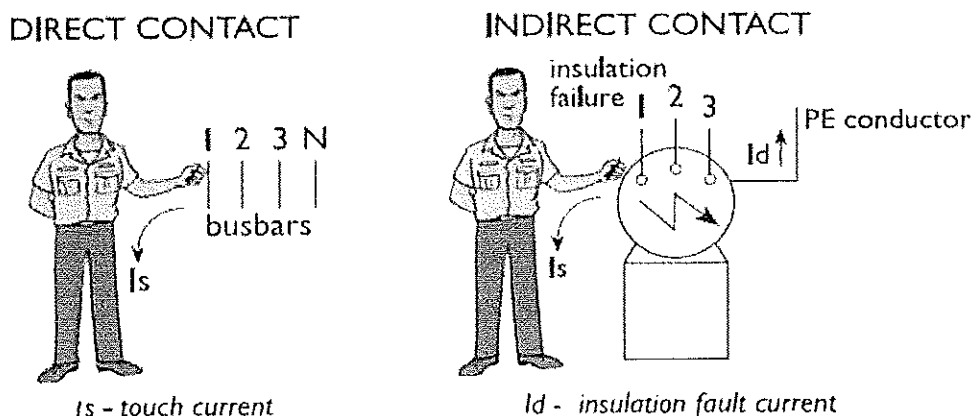Is - touch current   Id - insulation fault current

Figure Q3

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c) What are the different applications of AC and DC motors in your household? Give examples of each application with the reason of selecting the specific motor   [4 Marks]

d) Explain the reason for "Maximum demand Charge" applicable for industrial consumers?

[4 Marks]

e) What are the merits and demerits of a coal power plant when compared with a natural gas power plant   [4 Marks]

f)

Question 04

a) Figure Q4 shows the characteristics curves of DC motor. Identify type of the motor and derive expression for each characteristics from basic Principles.   [4 Marks]
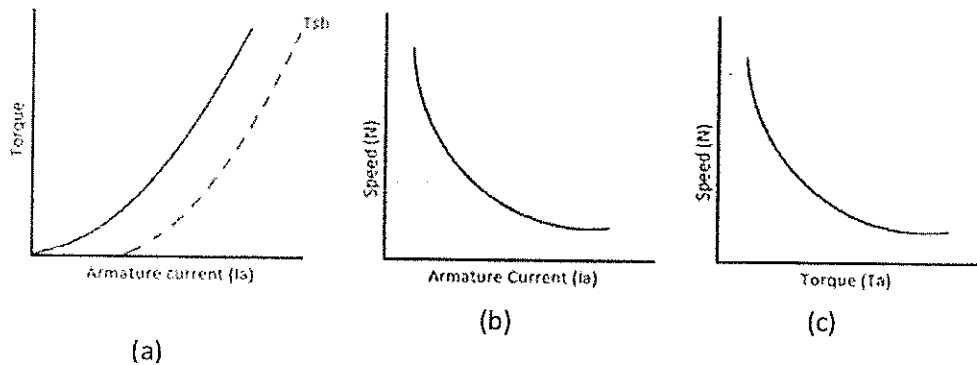

Figure Q4

b) A 230 V DC series motor has armature and field resistances of 0.15 Ω and 0.1 Ω respectively. It draws a current of 30 A from the supply while running at 1000 rpm. If an external resistance of 1 Ω is connected in series with this motor, calculate the new steady state armature current and the speed. Assume the load torque remains constant.

[16 Marks]

Question 05

a) Briefly explain the speed controlling methods applicable for DC shunt motors.   [4 Marks]

b) A 230 V DC shunt motor has armature and field resistances of 0.2 Ω and 230 Ω respectively. The motor is driving a load torque varies proportionally with the speed and running at 1000 rpm drawing 10 A current from the supply. If an external resistance of 5 Ω is inserted in the armature circuit, calculate the new steady state armature current and the speed.

Neglect armature reaction and saturation   [16 Marks]

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Question 06

a) Define the terms "Apparent power" and "Power factor".   [2 Marks]
b) Why it is important to maintain the power factor closer to unity? Give reasons.   [3 Marks]
c) A 230V, single phase, 50Hz induction motor draws a current of 40A at a power factor of 0.75 lagging. Determine
    i.   the real power taken from the supply
    ii.   the reactive power taken from the supply
    iii. Find the value of a capacitor connected across the terminal of the motor, which will raise the power factor to 0.95.   [15 Marks]

Question 07

a) What are the advantages of wound rotor induction motor when compared with squirrel cage rotor induction motor   [4 Marks]

b) A three phase induction motor having a synchronous speed of 1200 rpm draws 80 kW from a three-phase feeder. The copper losses and iron losses in the stator are measured as 5 kW. The windage and friction losses are 2 kW. If the motor runs at 1152 rpm, Calculate;

    i.   Power transmitted to the rotor
    ii.   Rotor Copper loss
    iii. The mechanical power developed
    iv. The shaft torque
    v.   The efficiency of the motor   [16 Marks]

Question 08

a. Explain the term "Harmonics" in power systems and what are the causes for power system harmonics?   [3 Marks]
b. How can you avoid harmonics in power system? Briefly explain two methods.   [2 Marks]
c. A 60 Hz source contains a fundamental of 730 V and a 5th harmonic of 108 V. The source is connected to an inductance of 7 mH in series with a resistance of 12 Ω. Calculate the effective values of the following current and voltages:

    i.   Fundamental current
    ii.   5th harmonic current
    iii. Current in the circuit
    iv. Voltage across the resister
    v.   Voltage across the inductor   [15 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.