The Open University of Sri Lanka
Diploma in Technology
ECX 3232-Electrical Power
Final Examination-2012/2013
Duration Three Hours
Date: 23rd of July 2013 **Time: 0930-1230 hrs.**

This paper contains Eight (8) questions. Answer any five (5). All questions carry equal marks. Graph papers will be available on your request.

1. a) Briefly describe the electricity tariff structure in Sri Lanka with emphasis on consumer types and different components of charges on them. **[3 Marks]**

b) A load variation through out a day of an 11 kV, three phase, 50 Hz industrial consumer is given in Table Q1A

Table Q1A

Time (hours)	0000-0900	0900-1500	1500-2100	2100-2400
Total Load (kW)	100	300	600	100
Load Description	Lighting Load only	Lighting Load + 200 kW induction motor load operating at 0.8 p.f.	Lighting Load+ 200 kW induction motor load operating at 0.8 p.f. + 300 kW induction motor load operating at 0.9 p.f.	Lighting Load only

A distribution company offers a choice of two electricity tariffs for the above consumer and it is given in Table Q1B.

Table Q1B

Description of the Charge		Tariff-1	Tariff-2
Demand Charge (Rs/kVA)		750	600
Energy Charge (Rs/kWh)	Peak (1800-2100)	15.00	27.00
	Off peak (other time)	15.00	12.50
Fixed Charge (Rs/Month)		2000	2000

Assuming a month of 30 working days

i) Calculate the load factor of the above consumer. **[2 Marks]**

ii) Determine the monthly electricity bills under Tariff-1 and Tariff-2 and hence advice and help the consumer to select the better tariff structure. **[10 Marks]**

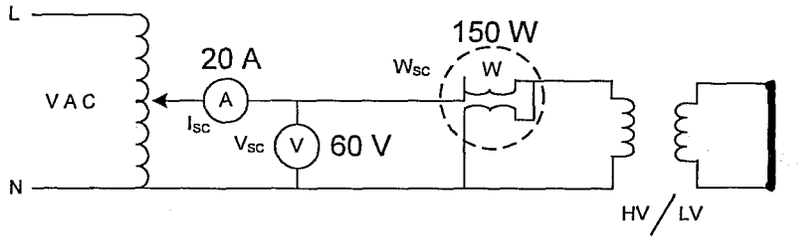
iii) Calculate the size of the capacitance/phase needed to be installed and switched:

a) Between 0900-1500 hrs
b) Between1500-2100 hrs to improve the power factor to be unity. (Assume that the capacitor banks are star connected) **[5 Marks]**

2. a) briefly explain the terms "Copper Loss" and "Iron Loss" of the power transformers and it variation with respect to load current. **[2 Marks]**

   b) State the condition of the above losses when the transformer operating at its maximum efficiency. **[2 Marks]**

   c) A 10 kVA, 500/250 V, single-phase transformer gave the following test results as indicated on the circuit diagram while performing a particular test.



   i. Identify the test and explain why all the instruments are connected on high voltage side of the transformer? **[2 Marks]**

   ii. Compute the relevant parameters and draw the equivalent circuit of the transformer referred to LV side (neglect the parallel branch) **[2 Marks]**

   iii. It was observed that the transformer is operating at its maximum efficiency when it is loaded to 1.2 times its full-load capacity at unity power factor. Determine the full-load efficiency of the transformer when it is operating at 0.8 power factor. **[8 Marks]**

   iv. Also calculate the maximum efficiency of the transformer. **[4 Marks]**

3. a) Briefly explain the torque-armature current characteristics of a D.C. shunt motor. **[4 Marks]**

   b) A 200 Volts D.C. Shunt motor takes 27 A at 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 in case load torque varies with the speed **[8 Marks]**

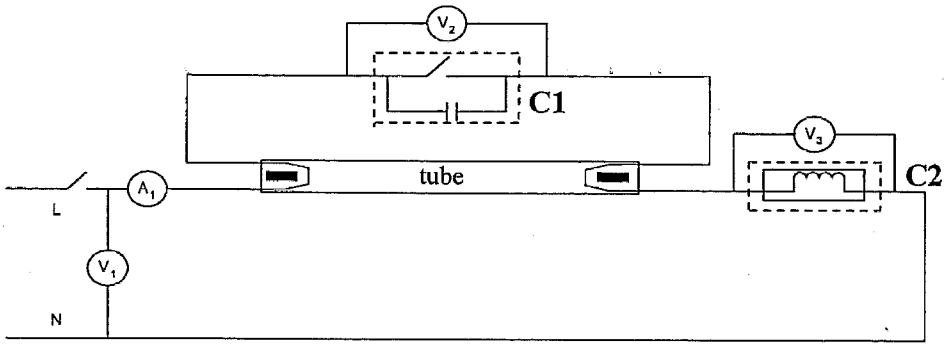
   ii. Motor speed and the line current in case load torque varies as the square of the speed. **[8 Marks]**

4. A 25 kW, 6 poles, 400V, 50 Hz, three phase induction motor operating at 0.85 power factor lagging has a full load slip of 0.04. If the torque lost in mechanical (friction & windage) losses is equivalent to 22 Nm, Compute:

a)	The mechanical torque available on the shaft	(τ_m)	**[3 Marks]**
b)	Electrical torque available on the shaft	(τ_e)	**[3 Marks]**
c)	Rotor ohmic loss	(P_{cu})	**[4 Marks]**
d)	Air gap power	(P_{ag})	**[4 Marks]**
e)	Motor input current	(I_a)	**[3 Marks]**
f)	Motor input efficiency	(η)	**[3 Marks]**

Assume that the total stator loss is 900 watts.

5. A circuit diagram for the observation of operational characteristics of a fluorescent lamp is as shown below:



a) Identify the components **C1** and **C2** and explain their functions? **[4 Marks]**

b) If the observations on Volt meters and the Ammeter are V_1=230V, V_2=103V, V_3=194 V and A_1=0.55A, do the followings:

i. Draw the equivalent circuit and phasor diagram when fluorescent tube is ignited. **[5 Marks]**

ii. Calculate the power factor of the lamp circuit, power consumed by the tube and C_2 **[5 Marks]**

c) If 6μF capacitor is connected in parallel to the main supply while maintaining V_1 at 230 volts, what would be the new power factor of the lamp circuit? **[6 Marks]**

6. A single phase 19.05 kV, 50 Hz transmission line feeds a load at several kilometers away from a substation as shown in figure Q6. The line has a resistance of 2.5 Ω and a reactance of 18 Ω. Instruments installed at the substation, indicate that the active and reactive power flow to the line are 4 MW and 2 MVAr respectively.

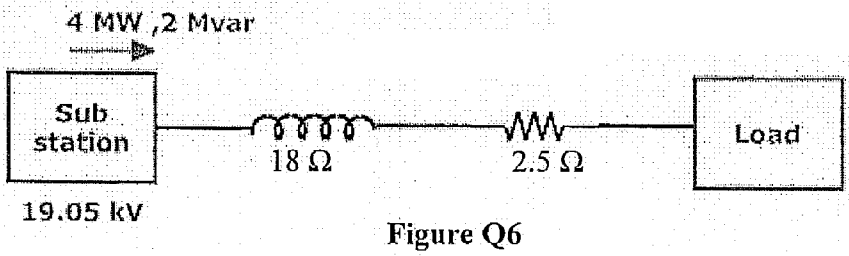


Figure Q6

a) Find apparent power delivered to the line, line current and its phase angle [reference to the substation voltage] **[5 Marks]**

b) Active power and reactive power dissipated in the line **[5 Marks]**

c) Active and reactive power absorbed by the load **[5 Marks]**

d) Voltage and power factor at the load end **[5 Marks]**

7. a) Briefly explain why low voltages are not suitable for electrical power transmission. **[5 Marks]**

   b) Why the ring main systems are better when compared with radial systems in electrical power distribution? **[5 Marks]**

   c) Semi enclosed ceramic fuses and MCBs (miniature circuit breaker) are protective devices used in domestic electrical installation, however their Time-Current characteristics are different. Explain? **[5 Marks]**

   d) Explain the term "Time of day" used in in electricity tariff offered by Ceylon Electricity Board. **[5 Marks]**

8. a) i. Define non-linear load and linear load? Give three examples for each **[3 Marks]**
   ii What are the problems associated in power systems owing to harmonics? **[3 Marks]**

   b) An e.m.f given by $e = 110\sin\omega t + 40\sin\left(3\omega t - \pi/6\right) + 10\sin\left(5\omega t - \pi/3\right)$ Volts is applied to a series circuit having a resistance of 110 Ω, an inductance of 35.6 mH and a capacitance of 15 μF. Derive an expression for the current in the circuit considering ω as 314 rad/sec. Also compute:

   i. r.m.s value of the current. **[8 Marks]**
   ii. Power dissipated in the circuit. **[2 Marks]**
   iii. Overall power factor. **[2 Marks]**
   iv. Total harmonic distortion (THD) **[2 Marks]**