The Open University of Sri Lanka
Department of Electrical and Computer Engineering
Diploma in Technology
ECX3232– Electrical Power
Final Examination-2013/2014
Duration: Three hours

Date: 05th August 2014 Time: 09.30-12.30hrs

This paper contains eight (8) questions. Answer any 5 questions. All questions carry equal marks.

(1)

a. Why different kinds of tariff systems are imposed by utilities for different type of consumers? **[3 Marks]**

b. What is the reason behind the demand charge (kVA) for industrial consumers? **[3 Marks]**

c. A load variation through-out a day of a certain consumer metered at 400/230 V nominal, 50 Hz, ac system is shown in Table Q1.

Table Q1

Time (hours)	**0000-0700**	**0700-1400**	**1400-1800**	**1800-2400**
Total Load (kW)	20	35	42	20
Load Description	Lighting Load only	Lighting Load +	Lighting Load +	Lighting Load only
		15 kW induction motor load operating at 0.85 p.f	22 kW induction motor load operating at 0.9 p.f.	

i. Draw the daily load curve and determine the load factor of above consumer. **[2 Marks]**

ii. What is the maximum demand? **[2 Marks]**

iii. What is the applicable tariff rate for this consumer? **[2 Marks]**

iv. Hence, determine the monthly electricity bill of this consumer. **[4 Marks]**

v. Calculate the size of the capacitance/phase in μF to be installed between 0700-1400 hrs to improve the power factor to unity. Assume that the capacitors are delta connected. **[4 Marks]**

Note: A month consist of 30 days. *Tariff rates offered from the utility is given in page 4*

(2)

a. State the transformer losses obtained from the open circuit test and short circuit test respectively. Also explain variations of these losses with respect to load current. **[4 Marks]**

b. Derive an expression for load (kVA) on a transformer at maximum efficiency. **[2 Marks]**

c. A 30 kVA, 1000/250 V single-phase transformer is subjected to short circuit test. All the equipments are connected to high voltage side and following readings were observed.

S.C. test: 80V, 30 A and 180 W

i. Determine the full load efficiency of the transformer at 0.8 power factor lagging where the maximum efficiency of the same transformer occurs at unity power factor and at 1.2 times full load current. **[10 Marks]**

ii. Calculate the maximum efficiency **[4 Marks]**

(3)

a. Derive an expression for the torque developed by a DC machine. **[2 Marks]**

b. Briefly explain the speed-torque characteristics of DC series motor. Assume no saturation. **[2 Marks]**

c. A DC motor takes an armature current of 110 A at 480 V. The armature circuit resistance is 0.2 Ω. The machine has 6 poles and armature is lap wound with 864 conductors. The flux per pole is 0.05 Wb. Calculate,

i. The speed of the motor **[3 Marks]**

ii. The gross torque developed by the armature **[3 Marks]**

d. A 200 V DC series motor takes 40 A when running at 700 rpm. Calculate the speed at which the motor will run and the current taken from the supply if the field is shunted by a resistance equal to the field resistance and the load torque is increase by 50%. Assume that the armature resistance = 0.15 Ω, field resistance = 0.1 Ω and flux per pole is proportional to the field. **[10 Marks]**

(4)

a. What are the no-load losses and full-load losses of an induction motor? **[2 Marks]**

b. A 10 kW, 400 V, three-phase, 4 pole, 50 Hz, delta connected induction motor is running at no load with a line current of 9A and an input power of 650 W. At full-load, the line current is 14 A and the input power is 11.5 kW. Stator effective resistance per phase is1.5 Ω. Friction and windage loss is 430 W. For negligible rotor ohmic loss at no load, calculate

i. Stator core loss **[3 Marks]**

ii. Total rotor losses at full load **[3 Marks]**

iii. Total rotor ohmic losses at full load **[2 Marks]**

iv. Full-load slip **[3 Marks]**

v. Internal torque and shaft torque **[3 Marks]**

vi. Motor efficiency **[2 Marks]**

c. Draw power flow diagram of above induction motor. **[2 Marks]**

(5)

a. List the equipments connected to power system that contributes to poor power factor. **[3 Marks]**

b. State the disadvantages of low power factor and suggest methods to improve the same **[4 Marks]**

c. An energy audit for a facility indicates following measurements at the load side of a three phase transformer; 480 V, 1200 A and 800 kW operating load at 50 Hz.

i. What is the Power Factor?

ii. How much Reactive Power is in the system?

iii. Determine the value of capacitance/phase needed to improve the power factor to 0.95. Assume capacitors are star connected. **[13 Marks]**

(6)

a. Compare merits and demerits of overhead and Underground electricity distribution. **[3 Marks]**

b. What are the main connection types of electricity distribution? **[3 Marks]**

c. A single phase, 50 Hz transmission line feeds a several loads at 4 km away from a substation as shown in Figure Q6.The line has a resistance of 0.5 Ω/km and reactance of 3 Ω/km. In order to maintain load end bus bar voltage to 230 V under these loads. Calculate,

i. The substation voltage (V_S) **[8 Marks]**

ii. Active and reactive power dissipated in the line **[6 Marks]**

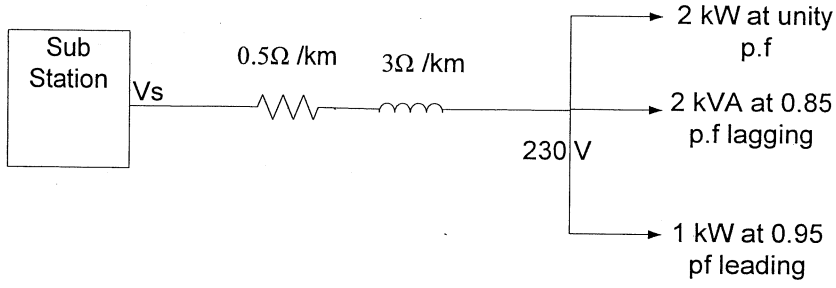

Figure Q6

(7)

a. What are the advantages of inter-connected grid system? **[5 Marks]**

b. Briefly explain why different level of voltages used for generation, transmission and distribution of electrical energy. **[5 Marks]**

c. Discuss the advantages and disadvantages of Hydro electric power station and compare it with thermal power station. **[5 Marks]**

d. What are the common protective devices used in your domestic wiring system? Briefly explain one of them. **[5 Marks]**

(8)

a. What are the effects of harmonic current on distribution transformer in a power system? **[3 Marks]**

b. Suggest methods to reduce the effect of harmonic current in power system. **[3 Marks]**

c. An e.m.f. $e = 200\sin\omega t + 40\sin 3\omega t + 10\sin 5\omega t$ is impressed on a circuit comprising of a resistance of 10 Ω, a variable inductor and a capacitance of 30 μF, all connected in series. Find the value of the inductance which will give resonance with triple frequency component and estimate the effective power factor of the circuit. ω= 300 rad/s. **[14 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	Energy charge (Rs/kWh)			Fixed Charge (Rs/ month)	Maximum Demand Charge per month (Rs/kVA)	Fuel adjustment charge (% of Energy Charge)
	Peak 1830-2230 hr	Off-Peak 2230-0530 hr	Day 0530-1830 hr			
Industry						
I-1	12.50			600		15
I-2	21.00	7.00	11.30	3,000	1,100	15

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