The Open University of Sri Lanka
Department of Electrical and Computer Engineering
Diploma in Technology
ECX3232– Electrical Power
Final Examination - 2011/2012
Duration : Three hours.

Date: 21st February 2012 Time: 0930-1230 hrs

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

1) a. A 150 kVA transformer has 400 turns on the primary and 80 turns on the secondary. The primary and secondary winding resistances are 0.3 Ω and 0.01 Ω respectively, and the corresponding leakage reactances are 1.1 Ω and 0.035 Ω respectively. The voltage across the load is maintained at 400 V. The transformer supplies a load of 90 kW at a power factor of 0.8 lagging.
Calculate;
i. Primary voltage. [8 marks]
ii. Copper loss at the above load. [3 marks]

b. The iron loss of the transformer in 'a' is 500 W. It operates on the following daily cycle,
6 hours on full load, unity power factor
10 hours with 90 kW, 0.8 power factor lagging load
8 hours on no-load
Calculate;
i. Efficiency at 90 kW, 0.8 p.f. lagging, [3 marks]
ii. All day efficiency of the transformer. [6 marks]

2) A sugar factory generates electricity to meet its own power requirement, using a power plant of 750 kW, driven by sugar cane waste. A new machinery unit of 300 kW, 0.8 p.f. lagging is to be added to the factory's production line. This machine is to operate for 12 hours within the peak load hours of the factory, 250 days a year.

To meet this demand the following two alternatives are available

i. Purchasing another generating unit of 500 kVA, at 2500 Rs./kVA. The cost of generation of this unit is 3 Rs. /kWh.
ii. Purchasing power from the grid supply at Rs.200 per kVA maximum demand, and 8 Rs./kWh.

Calculate;
a. Cost for purchasing the generator unit [2 marks]
b. Increase in maximum demand of the factory [4 marks]
c. Increase in the energy units consumed per annum [4 marks]
d. Annual cost for generating power to meet the increased demand [3 marks]
e. Annual cost for purchasing power from the grid to meet the increased demand [4 marks]
f. Which alternative is cheaper and by what value? [3 marks]

(You may consider only the increase in the electricity bill for the two methods, neglecting capital cost and depreciation of the generator unit in alternative i , for part f)

3) a. A single-phase radial distributor is shown in figure Q3a. The power source feeds a 100 kVA, 16/2.4 kV transformer through a transmission line of impedance 40 + *j*150 Ω. Consider the transformer to be ideal. The load on the transformer is 92 kW at 0.80 p.f. lagging, at 2300 V.

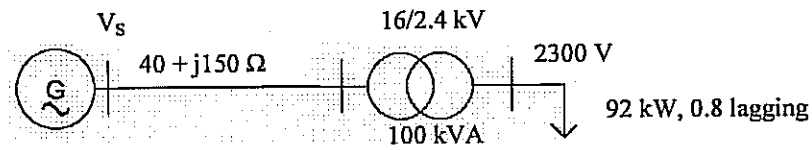

Figure Q3a

Calculate;

i. Source voltage V_S. [8 marks]
ii. Voltage regulation of the transmission line. [3 marks]
iii. Overall efficiency of the system. [5 marks]

b. An Electrical Engineering undergraduate suggests using the arrangement shown in figure Q3b, to feed the above load, under the same conditions. The transformer in figure Q3a, is replaced by another ideal transformer, TF_{new}. The price and installation & maintenance cost for both the transformers are equal. None of the other components will be replaced.

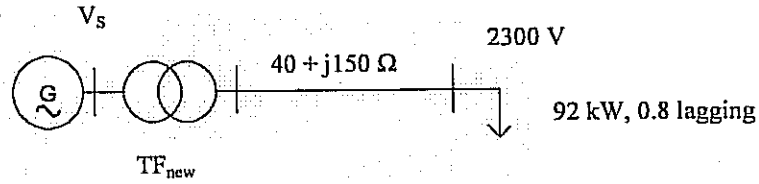

Figure Q3b

Which arrangement is more desirable? Justify your answer with appropriate calculations. [4 marks]

4) a. The out put of a certain amplifier is given by ;

$$V(t) = V_0\sin(\omega t) + V_1(3\omega t + \theta_1) + V_2(5\omega t + \theta_2) \text{ Volts}$$

Write expressions for;

i. R.M.S value, [2 marks]
ii. Total harmonic distortion of voltage. [3 marks]

b. The wave forms of supplied voltage and the corresponding current to a circuit are given by;

$$V(t) = 350\sin(\omega t) + 50\sin(3\omega t + 7\pi/6) \text{ Volts and}$$

$$i(t) = 14\sin(\omega t - \pi/6) + 5\sin(3\omega t + 2\pi/3) + \sin(5\omega t - \pi/6) \text{ Amps}$$

Determine;

i. The active power supplied to the circuit. [5 marks]
ii. Overall r.m.s. value of the *voltage* and *current*. [6 marks]
iii. Total-harmonic-distortion of the current. [4 marks]

5) The power input to a 6 pole, 50 Hz, 3 phase induction motor is 700 W at no-load and 10 kW at full load. The no-load copper loss may be assumed negligible while the full-load stator and rotor copper losses are 925 W and 310 W respectively. Mechanical losses and stator core loss is equal.

Calculate,

a. Air gap power. [5 marks]
b. Full load speed. [5 marks]
c. Shaft torque. [5 marks]
d. Efficiency of the motor at full-load. [5 marks]

6) A four-pole dc motor is lap wound and has eight rotor coils and four turns per coil. It is connected to a 12 V battery.

a. If the speed of the motor is 900 rpm at no load, calculate the flux per pole. [8 marks]
b. If this motor is loaded so that it consumes 50 W from the battery, calculate the induced torque of the motor. (Ignore any internal resistance in the motor.) [4 marks]
c. How many brushes should this motor have? [3 marks]
d. Calculate the speed of the motor if it was wave wound, and has the flux per pole found in 'a'. [5 marks]

7) a. Give standard symbols for the following.

Socket outlet	Switched socket outlet	Single pole, two way switch
Fuse	Fluorescent lamp	Two pole, one way switch
Buzzer	Intermediate switch	
Ceiling fan	Electric bell	

[10 marks]

b. Explain why it is preferred to transmit electricity at high voltages and low currents. [5 marks]

c. An appliance with a 3 pin plug is to be used in a certain household. It was observed that the RCCB of the house trips when this appliance is plugged in. Explain the likely reason for this.
What is the risk posed if the RCCB does not operate properly? [5 marks]

8) A 10 kW, 30 V shunt wound generator has the data given in table Q8, for its magnetization curve at the speed of 4500 rpm. Its terminal voltage is kept constant at the rated value by varying the field resistance. The armature resistance is 0.04 Ω and the field resistance is set to 3.75 Ω.

I_f (A)	0	2	4	5	6	8	11.7
E_g (V)	1	18	31	34	36	38	41

Table Q8

A load test is done on the generator at 4550 rpm. Calculate;

a. The generated e.m.f [9 marks]
b. Armature current [4 marks]
c. Efficiency of the generator if mechanical loss is 300 W. [7 marks]