The Open University of Sri Lanka
Diploma in Technology
ECX 3232-Electrical Power
Final Examination-2006

Duration Three Hours
Date: March 28th 2007 **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 Voltage of (2000 Sin ωt – 500 Sin 3ωt) V is applied to a 250 turns transformer winding having negligible resistance and leakage reactance. Deduce an expression for the flux (Φ) and find its maximum value? (assume ω= 100π)

   The eddy current loss of a transformer can be controlled by controlling its flux and frequency. Also, the eddy current loss is directly proportional to the product of B^2 & f^2 (B = flux density & f = frequency).

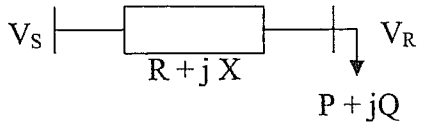
   By what percentage will the eddy current loss in the above transformer core be reduced if the applied voltage is altered to 2000 Sin ωt?

2. The variation of load P (kW) with time t (hours) in a power supply system is given by the equation:

$$P(kW) = 4000 + 8t - 0.0009t^2$$

   Where t is in hours over a total period of one year
   This load is supplied by three 10 MW generators and it is advantageous to fully load one generator at a time before connecting the other.
   Determine:
   a) The Average load
   b) load factor of the system (L.F=Average Load/Maximum Load)

3. Show that the voltage drop ΔV= (V_S-V_R) of a distribution network as shown below can be estimated as:



$$(V_S - V_R) = \Delta V \approx \frac{PR+QX}{V_R}$$

   where V_s = Sending end voltage
   V_R = Receiving end voltage

   What load can be delivered by a 3 phase overhead line 5 km long with a voltage drop of 10 %, Given that the sending end voltage is 11 kV, resistance per km of each line is 0.09 Ω, reactance per km 0.08 Ω and the power factor of the load 0.8 lagging.?

4. An Industrial consumer "XYZ" operated at 0.9 p.f., on three shift/day basis, fed by a certain local electricity supply is metered at 400V/230V. Variation of his daily load pattern (including week-ends & holidays) is as given below:

Industry "XYZ"

Shift-1				
From	midnight	to	1.00 a.m.	15 kW
	1.00 a.m.	to	7.00 a.m.	45 kW
	7.00 a.m.	to	8.00 a.m.	15 kW
Shift-2				
From	8.00 a.m.	to	9.00 a.m.	15 kW
	9.00 a.m.	to	3.00 p.m.	45 kW
	3.00 p.m.	to	4.00 p.m.	15 kW
Shift-3				
From	4.00 p.m.	to	5.00 a.m.	15 kW
	5.00 p.m.	to	11.00 p.m.	45 kW
	11.00 p.m.	to	midnight	15 kW

a) Plot the load variation during 24 hours for the consumer
b) Find out the maximum and minimum demand
c) What are the Maximum Demand charge, Energy charge and fixed charge under the customer category of "Industrial **(Time of Day)**"?
d) What are the Maximum Demand charge, Energy charge and fixed charge under the customer category of just "Industrial"?
e) Compute the energy consumption for a 30 day month, and hence prepare the monthly electricity bill for the consumer under the category of "Industrial **(Time of Day)**"?
f) Prepare the monthly electricity bill for the consumer under the category of just "Industrial"?
g) Based on the answers you get for the parts (e) and (f), what tariff structure would you recommend for the consumer "XYZ"?

(You may use the tariff table attached to this question paper i.e. page [4] of [4] when answering (c), (d), (e), (f) parts of the above question)

5. Magnitude of an r.m.s. current is found to be 6A. It contains a third harmonic component and is passed through a coil having a resistance of 1.5 Ω and an inductance of 12 mH. The r.m.s. voltage across the coil is 25 V. Calculate the magnitude of the fundamental and harmonic components of current if the fundamental frequency is $300/2\pi$ Hz. Also, find the power dissipated.

6. In a 25 kVA 2000/200 V transformer, the iron and copper losses at full load are 350 W and 400 W respectively. Calculate the efficiency on unity power factor at:
   a) full-load
   b) Half-load
   c) Determine the iron loss and copper loss at maximum efficiency
   d) Determine the load for maximum efficiency
   e) The maximum efficiency

7. A 4 pole, 900 r.p.m., d.c. machine has a terminal voltage of 220 V and an induced voltage of 240 V at rated speed. The armature circuit resistance is 0.2 Ohm. Is the machine operating as a generator or a motor? Compute the armature current and the number of armature conductors, if the air-gap flux/pole is 10 mWb. The armature is wave wound.

8. A 6 pole, 50 Hz, 3 phase induction motor running on full load develops a useful torque of 165 Nm., and it is observed that the rotor electromotive force makes 90 complete cycles per minute. Calculate:

- The motor slip (s)
- The break horse power.
- If the mechanical torque lost in friction is 14 N-m., Find the copper loss in the rotor windings
- The power input to the motor
- The Input current to the stator
- The efficiency of the motor if the stator loss is 750 W.

(Assume that 1 hp = 0.746 kW)

Tariff table for Q4

Customer Category	Conditions	Maximum demand charge Rs./kVA per month	Energy Charge Rs./kwh	Fixed Charge Rs./month
Domestic	Metered at 400V/230V	-	1-30 Units @ 3.00 31-60 Units @ 4.70 61-90 Units @ 5.10 91-180 Units @ 12.10 Above 180 Units @ 17.30	60.00 90.00 120.00 180.00 240.00
Religious	Metered at 400V/230V	-	1-30 Units @ 2.50 31-90 Units @ 3.70 91-180 Units @ 5.50 Above 180 Units @ 8.70	60.00 90.00 180.00 240.00
General Purpose All buildings except industries & some hotels	Metered at 400V/230V contract demand < 42 kVA Demand up to 10 kVA Demand above 10 kVA	-	 11.90 11.90	 240.00 500.00
	contract demand > or = 42 kVA Metered at 400V/230V Metered at 11/33/132 kV	 480.00 460.00	 11.80 11.70	 3000.00 3000.00
Industrial	Metered at 400V/230V contract demand < 42 kVA Demand up to 10 kVA Demand above 10 kVA	-	 8.50 8.50	 240.00 500.00
	contract demand > or = 42 kVA Metered at 400V/230V Metered at 11/33/132 kV	 400.00 380.00	 8.10 8.00	 3000.00 3000.00
Industrial **(Time Of Day)** Includes some hotels	Metered at 400V/230V contract demand < 42 kVA Demand up to 10 kVA Demand above 10 kVA	-	 16.00 bet 7-10 p.m. 7.90 at other times	 240.00 500.00
	Metered at 400V/230V contract demand > or = 42 kVA	380.00	22.00 bet 7-10 p.m. 7.50 at other times	3000.00
	Metered at 11/33/132 kV contract demand > or = 42 kVA	360.00	20.00 bet 7-10 p.m. 7.10 at other times	3000.00
Hotels(GP)	Metered at 400V/230V contract demand > or = 42 kVA	480.00	11.80	3000.00
Hotels(Industry)	contract demand > or = 42 kVA Metered at 400V/230V Metered at 11/33/132 kV	 480.00 380.00	 8.10 8.00	 3000.00 3000.00
Hotels **(Time of day)**	contract demand > or = 42 kVA Metered at 400V/230V Metered at 11/33/132 kV	 380.00 360.00	 22.00 bet 7-10 p.m. 7.50 at other times 20.00 bet 7-10 p.m. 7.10 at other times	 3000.00 3000.00
Supplies to licensees LECO/LA	Supply at 400/230 V Supply at 11k V & above	240.00 220.00	8.80 6.90	