The Open University of Sri Lanka
Diploma in Technology
ECX 3232-Electrical Power
Final Examination-2005

Duration Three Hours
Date: May 02nd 2006 **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. The flux Φ linked by a coil of 100 turns varies during the period **T** of one complete cycle as follows;

   From $t = 0.0$ to $t = T/2$, $\Phi = \Phi_m\left(1 - \frac{4t}{T}\right)$; and

   From $t = T/2$ to $t = T$, $\Phi = \Phi_m\left(\frac{4t}{T} - 3\right)$.

   If **T** be 1/50 sec., and Φ_m be 2 mega lines, calculate the maximum value of the induced electromotive force. Plot to scale the flux and electromotive force waves.
   (Assume that 10^8 mega lines = 1 wb)

2. Two domestic consumers "A" & "B" are fed by a certain local electricity supply metered at 400V/230V. Variation of their daily load patterns (including week-ends & holidays) are as given below:

   Consumer A

From	midnight	to	7.00 a.m.	250 W
	7.00 a.m.	to	6.00 p.m.	No load
	6.00 p.m.	to	7.00 p.m.	2500 W
	7.00 p.m.	to	9.00 p.m.	4000 W
	9.00 p.m.	to	mid night	500 W

   Consumer B

From	midnight	to	9.00 a.m.	500 W
	9.00 a.m.	to	12.00 noon	200 W
	12.00 noon	to	5.00 p.m.	700 W
	5.00 p.m.	to	7.00 p.m.	No load
	7.00 p.m.	to	mid night	3500 W

   a) Plot the load variation during 24 hours for each consumer?
   b) Hence find out the maximum and minimum demand for each consumer?
   c) Plot the total load variation during 24 hours and hence find the maximum power that has to be delivered by the electric supplier
   d) Compute the energy consumption by each consumer, and hence prepare the monthly electricity bill for each consumer (You may use the attached tariff table for the computation of monthly electricity charges)

3. The efficiency, at unity power factor (p.f.=1), of a 6600/384 V, 200 kVA, single phase transformer is 98% both at full-load and half-load. The power factor on no-load is 0.2. The full-load regulation at a lagging-power factor of 0.8 is 4%. Draw the equivalent circuit referred to the low voltage side and show all the values of the parameters.

Hint: You may neglect the magnetizing branch when doing the voltage reg. calculation.

Also assume that $\left[\text{Voltage regulation} = \frac{(V_S - V_R)}{V_S} \approx \frac{(I.R.Cos\varphi + I.X.Sin\varphi)}{V_S}\right]$

4. A single phase, 50-cycles/sec generating station supplies an inductive load of 5000 kW at a power factor of 0.71 by means of an overhead transmission line 5 km long. The resistance of the line is 0.0345 Ω/km. and the inductance is 1.5 mH/km. The voltage at the receiving end is maintained constant at 10 kV, and a capacitor is connected across the load to raise the power factor to 0.9 lagging. Calculate:

   a) The value of the capacitor
   b) The generating-station voltage when the capacitor is connected
   c) The generating-station voltage when the capacitor is disconnected

5. What non-linear equipments installed in power system, generate harmonic frequencies? Define the term Total Harmonic Distortion (THD)?

A voltage $e = 250\,Sin\,\omega t + 50\,Sin\left(3\omega t + \frac{\pi}{3}\right) + 20\,Sin\left(5\omega t + \frac{5\pi}{6}\right)$ is applied to a circuit of resistance 20 Ω and inductance 0.05 H. Derive:

(a) An expression for current
(b) The r. m. s. value of the current and of the voltage
(c) The total power supplied and
(d) The power factor

Consider ω = 314 in your calculations.

6. Three 1Φ loads are connected to a 2000 kVA transformer as shown below in fig. Q6. Copper loss and iron loss when delivering the rated power are 40 kW and 22 kW respectively. Behavioral pattern of the loads connected to the transformer during a normal working day is given in table Q6.

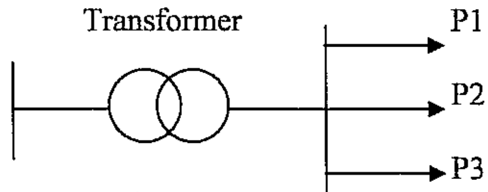

Fig. Q6

Table Q6

Time	Load-1 (P1)		Load-2 (P2)		Load-3(P3)	
	P(kW)	cos(ø)	P(kW)	cos(ø)	P(kW)	cos(ø)
6.00 a.m. - 12.00 noon	400	0.8	100	0.75	300	0.9
12.00 noon - 4.00 p.m.	600	0.9	300	0.85	450	0.95
4.00 p.m. -9.00 p.m.	250	0.9	400	0.95	700	1.00
9.00 p.m. – 6.00 a.m.	No load	No load	No load	No load	200	1.00

i. Calculate the power and power factor of the equivalent load during the given time periods?
ii. Find the total energy required during a day?
iii. Find the power loss of the transformer in each period?
iv. Calculate the energy efficiency of the transformer?

7. What are the different types of D. C. generators? Explain with diagrams.

A 4 poles, 500 V, DC shunt motor has 720 wave-connected conductors on its armature. The full-load armature current is 60 A, and the flux per-pole is 3 mega lines. The effective armature resistance is 0.2 Ω, and the contact drop is 1 volt per brush. Calculate the full-load speed of the motor. (Assume: 10^8 flux lines = 1 wb)

A series DC motor of resistance 1 Ω between terminals runs at 800 r.p.m at 200 volts with a current of 15 amps. Find the speed at which it will run when connected in series with 5 Ω resistance and taking the same current at the same supply voltage.

8. A 3Φ, 500 V, 50 cycles/sec induction motor with 6 poles develops 20 h.p at 950 rev/min with a power factor of 0.86. The mechanical losses totals 1 h.p. calculates for this load:

a) The moor slip (s)
b) The rotor copper loss
c) The input power to the motor, if the stator (wdg. + core) losses is 1500 Watts
d) The line current.

(Assume 746 watts = 1 hp)

Tariff table for Q2

Customer Category	Conditions	Maximum demand charge Rs./kVA per month	Energy Charge Rs./kwh	Fixed Charge Rs./month
Domestic	Metered at 400V/230V	-	0-30 Units @ 3.00 31-60 Units @ 3.70 61-90 Units @ 4.10 91-180 Units @ 10.60 Above 180 Units @ 15.80	30.00
Religious	Metered at 400V/230V	-	0-30 Units @ 2.50 31-90 Units @ 2.70 91-180 Units @ 4.00 Above 180 Units @ 7.20	30.00
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	-	10.90 10.90	30.00 230.00
	contract demand > or = 42 kVA Metered at 400V/230V Metered at 11/33/132 kV	480.00 460.00	10.80 10.70	800.00 800.00
Industrial Includes some hotels	Metered at 400V/230V contract demand < 42 kVA Demand up to 10 kVA Demand above 10 kVA	-	7.50 7.50	30.00 230.00
	contract demand > or = 42 kVA Metered at 400V/230V Metered at 11/33/132 kV	400.00 380.00	7.10 7.00	800.00 800.00
Industrial Time Of Day Includes some hotels	Metered at 400V/230V contract demand < 42 kVA Demand up to 10 kVA Demand above 10 kVA	-	15.00 bet 7-10 p.m. 6.90 at other times	30.00 230.00
	Metered at 400V/230V contract demand > or = 42 kVA	380.00	14.70 bet 7-10 p.m. 6.50 at other times	800.00
	Metered at 11/33/132 kV contract demand > or = 42 kVA	360.00	14.00 bet 7-10 p.m. 6.10 at other times	800.00
Supplies to licensees LECO/LA	Supply at 400/230 V Supply at 11k V & above	240.00 220.00	7.20 5.40	-
Standby Tariff	Supply at 400/230 V Supply at 11k V & above	100.00 90.00	7.10 7.00	800.00 800.00
Street Lighting	-	-	7.80	-