Uva Wellassa University, Sri Lanka
End Semester Examination – September 2012
SCT 369-2 Electric Power and Machines

Time: Two (02) hour

Total **04** questions
Answer **all** questions

1)

I. What is the commutation of a DC machine?

(05 marks)

II. What are the common speed control methods used by a shunt DC motor. Explain one (01) method briefly.

(10 marks)

(a) Write an expression for the voltage out of the armature (E_A) of a real DC generator having ***a*** number of current paths. This generator has a total number of conductors Z of an effective length of l, rotating at a velocity v in the presence of a field having a magnetic flux density B.

(05 marks)

(b) Use the above expression to prove that $E_A = K\phi\omega$,

Where,
ϕ- flux per pole
ω- angular velocity of the conductors
K- a constant

(20 marks)

III. A 240-V 100-A DC **shunt** motor has the following characteristics

$R_A = 0.14\ \Omega$ $N_F = 1500$ turns

$R_F = 200\ \Omega$ $n_m = 1200$ r/min

$R_{adj} = 0$ to $300\ \Omega$, currently set to $120\ \Omega$

This motor has compensating windings and interpoles. The magnetization curve for this motor at 1200 r/min is shown in figure 01. Answer the following

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(a) Calculate the field current when R_{adj} = 120 Ω?

(10 marks)

(b) Calculate the no-load speed of this motor when R_{adj} = 120 Ω?

(15 marks)

(c) Calculate the full-load speed?

(15 marks)

(d) Under no-load conditions, calculate the maximum and minimum speeds that can be achieved by adjusting R_{adj}?

(20 marks)

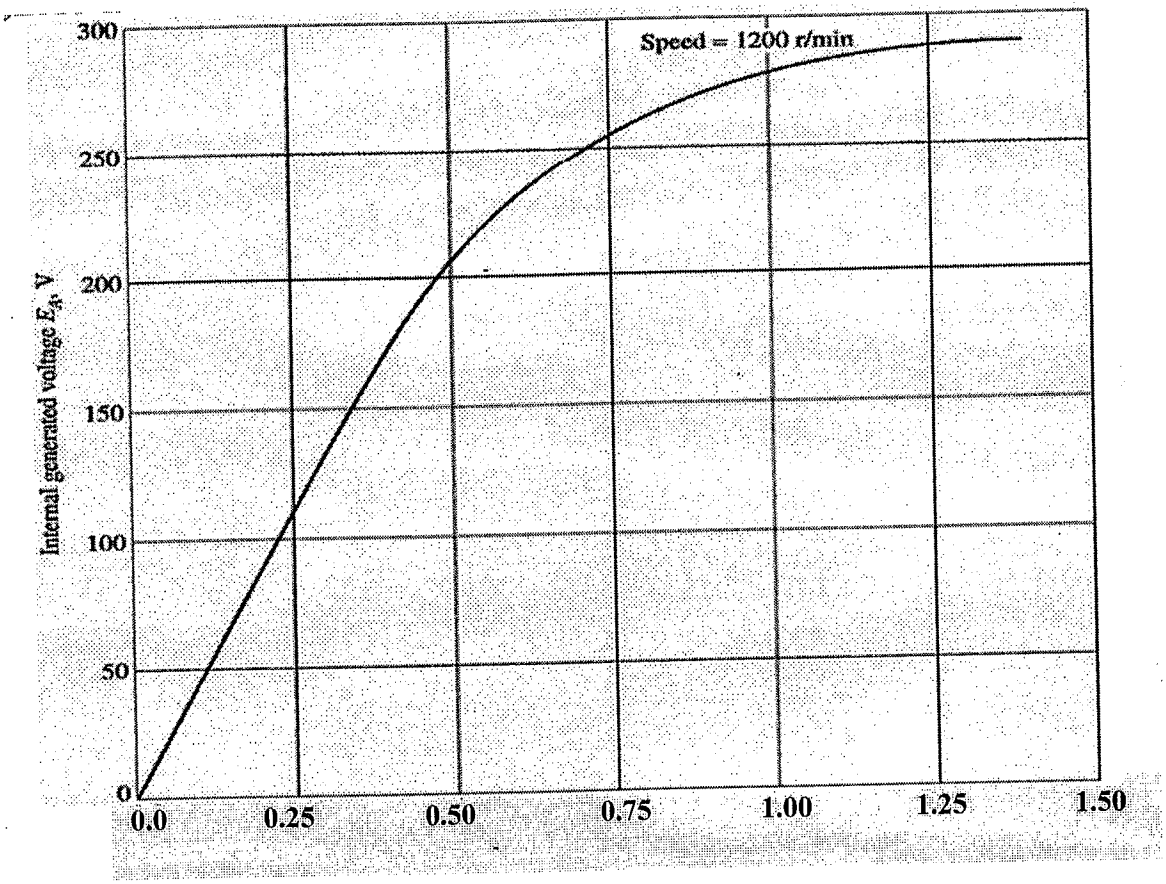

Fig. 01

2)

I. Briefly explain the slip of an induction motor.

(10 marks)

II. Draw the per phase equivalent circuit of an induction motor with standard notation. Name the components used in this circuit model. What does each component represents in the equivalent circuit.

(30 marks)

III. A 50-kW, 440-V, 50-Hz, six-pole induction motor has a slip of 6 percent when operating at full-load conditions. At full-load conditions, the friction and windage losses are 300 W, and the core losses are 600 W.
Find the following values for full-load conditions:

(a) The shaft speed n_{nr}

(12 marks)

(b) The output power in watts.

(12 marks)

(c) The load torque τ_{load} in newton-meters.

(12 marks)

(d) The induced torque τ_{ind} in newton-meters.

(12 marks)

(e) The rotor frequency in Hertz

(12 marks)

3)

I. Figure 02 shows a schematic symbol of an ideal transformer.

(a) Mark the current and voltage of the primary side and the secondary side according to the dot convention.

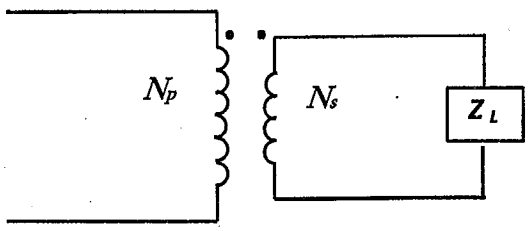

Fig. 02

(05 marks)

(b) Write an expression for the primary impedance (Z'_L) and the secondary impedance (Z_L) in terms of voltage and current.

(10 marks)

(c) Obtain a relationship between the two impedances if the turns ratio is *a*.

(10 marks)

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II.

(a) Use the following data to calculate the component values of the transformer equivalent circuit.

(30 marks)

Open Circuit Test	Short Circuit Test
V_{oc} = 480 V	V_{sc} = 10.0 V
I_{oc} = 0.41 A	I_{sc} = 10.6 A
P_{oc} = 38 W	P_{sc} = 26 W

(b) Draw the circuit with reference to the primary side and the secondary side.

(20 marks)

III.

(a) Write the advantages of autotransformer.

(10 marks)

(b) Redraw the diagram in the figure 02 as a step-down autotransformer with standard notation.

(15 marks)

4)

I. Consider a simple 3-phase AC machine stator containing three coils. Assume the currents in three coils are:

$I_{aa'} = I_M \sin \omega t$

$I_{bb'} = I_M \sin (\omega t - 120^0)$

$I_{cc'} = I_M \sin (\omega t - 240^0)$

(a) If the magnetic flux intensities due to the current flow are $H_{aa'}$, $H_{bb'}$ and $H_{cc'}$, obtain a set of expressions for the magnetic flux densities with standard notation.

(15 marks)

(b) Obtain the net magnetic flux density (B_{net}) when $\omega t = 0$ and $\omega t = 90$.

(20 marks)

(c) Compare the above two values and write your conclusion.

(15 marks)

II. Draw the power flow diagram of an AC motor.

(15 marks)

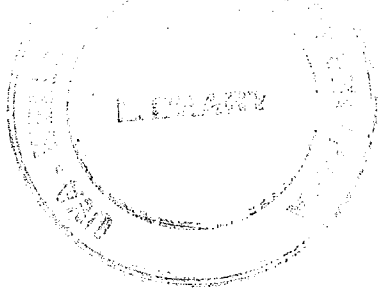
III. A two-pole three-phase Y-connected 50-Hz machine has a stator with 2000 turns of wire per phase. It is required to produce a terminal (line-to-line) voltage of 6 kV.

(a) Write an equation for the rms voltage in any phase of a 2-pole 3-phase stator.

(05 marks)

(b) Calculate the rotor flux required to produce a terminal voltage of 6 kV.

(30 marks)



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