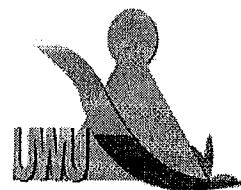


Uva Wellassa University, Sri Lanka
End Semester Examination – August/September 2011
SCT 369-2 Electric Power and Machines
Time: Two (02) hours



Total 04 Questions
Answer all questions
All questions carry equal marks

01)

- I. Using winding diagrams explain the difference between Lap Winding and Wave Winding for a DC motor. (20 marks)
- II. Explain the mechanism that is used to get DC voltage out of a rotating loop. (20 marks)
- III. A simple 4 loop, 2 pole DC machines is shown in the following figure (Fig.1). The following information is given about this machine:
 $B = 10 \text{ T}$ (flux in air gap)
 $l = 0.3 \text{ m}$ (length of coil sides)
 $r = 0.08 \text{ m}$ (radius of coils)
 $n = 1700 \text{ r/min}$ (Speed)
 The resistance of each rotor coil is 0.04Ω

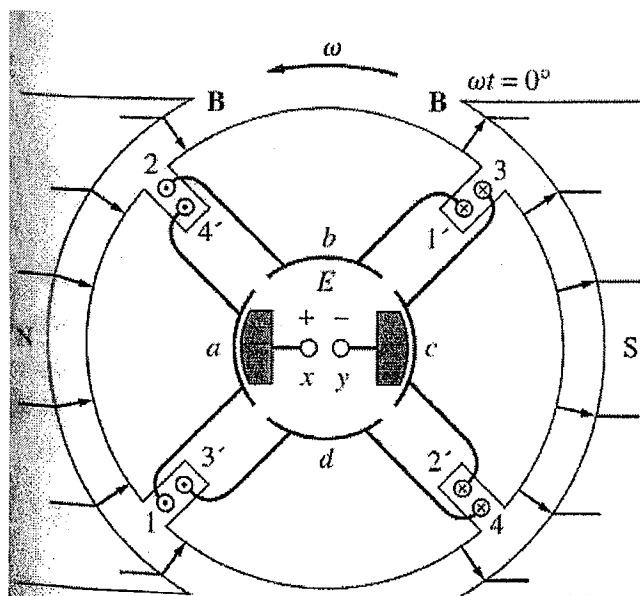


Fig.1

a) How many current paths are there through the armature of this machine? Explain your answer.

(15 marks)

b) What are the magnitude and the polarity of the voltage at the brushes in this machine? Explain your answer.

(15 marks)

c) What is the armature resistance R_A of this machine?

(15 marks)

d) If a $10\ \Omega$ resistor is connected to the terminals of this machine, how much current flows in the machine? Consider the internal resistance of the machine determining the current flow.

(15 marks)

02)

I. What is armature reaction and explain how it can be minimized in a real DC Machine.

(15 marks)

II. Following values are given for a shunt DC motor.

$$P_{\text{rated}} = 15\text{ hp}$$

$$I_{L,\text{rated}} = 55\text{ A}$$

$$V_T = 240\text{ V}$$

$$N_F = 2700\text{ turns per pole}$$

$$n_{\text{rated}} = 1200\text{ r/min}$$

$$R_F = 100\ \Omega$$

$$R_A = 0.40\ \Omega$$

$$R_{\text{adj}} = 100\text{ to }400\ \Omega$$

$$R_S = 0.04\ \Omega$$

Magnetization curve of the motor is shown in the figure Fig.2

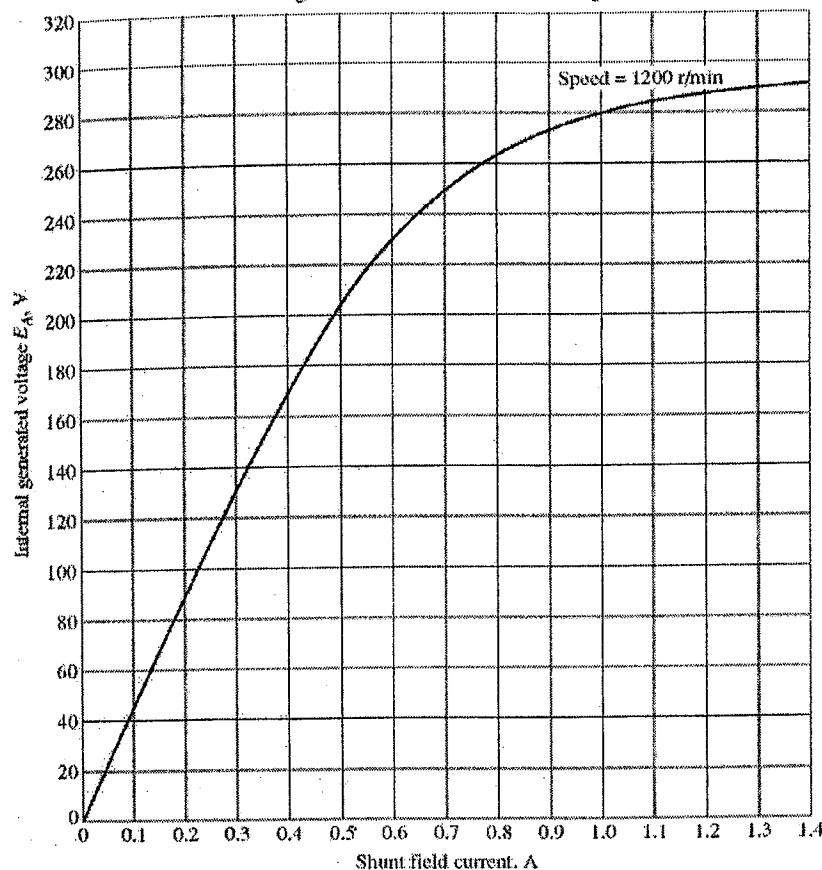


Fig. 2

- Draw the equivalent circuit for a shunt DC Motor and name all the components in standard notation. (15 marks)
- If the resistor R_{adj} is adjusted to 175Ω , what is the rotational speed of the motor at no-load conditions? (15 marks)
- Assuming no armature reaction, what is the speed of the motor at full load? What is the speed regulation of the motor? (10 marks)
- If the motor is operating at full load and if its variable resistance R is increased to 250Ω , what is the new speed of the motor? Compare the full-load speed of the motor with $R_{adj} = 175 \Omega$ to the full-load speed with $R_{adj} = 250 \Omega$. (Assume no armature reaction, as in the previous problem.) (15 marks)

e) Assume that the motor is operating at full load and that the variable resistor R_{adj} is 1Ω . If the armature reaction is 1200 A turns at full load, what is the speed of the motor? (15 marks)

f) What is the starting current of this machine if it is started by connecting it directly to the power supply V_T ? (15 marks)

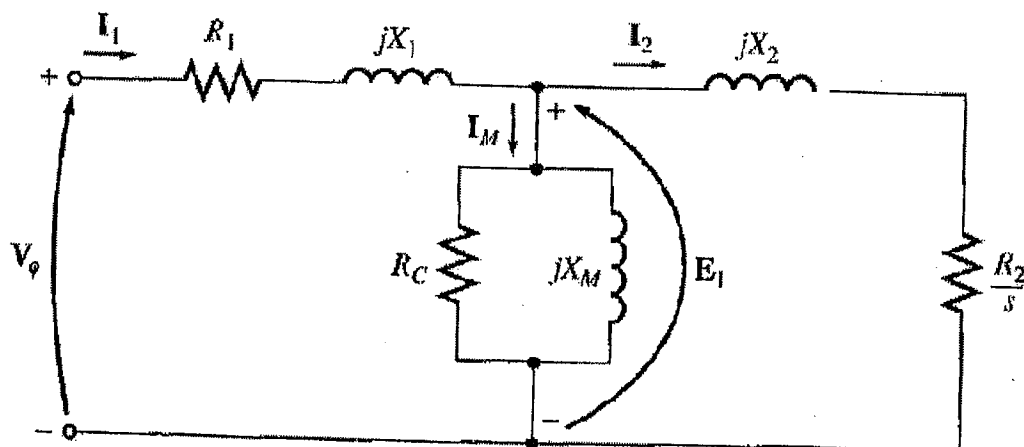
03)

I. Explain synchronous speed for an induction motor. (10 marks)

II. Explain how induction torque is generated in an induction motor. (10 marks)

III. A 208-V, two-pole, 60-Hz Y-connected wound-rotor induction motor is rated at 15 hp. Its per phase equivalent Circuit components are

$$\begin{array}{lll} R_1 = 0.200 \Omega & R_2 = 0.120 \Omega & X_M = 15.0 \Omega \\ X_1 = 0.410 \Omega & X_2 = 0.410 \Omega & \\ P_{\text{mech}} = 250 \text{ W} & P_{\text{misc}} \approx 0 & P_{\text{core}} = 180 \text{ W} \end{array}$$



For a slip of 0.05, find

- (a) The line current I_L (20 marks)
- (b) The stator copper losses P_{SCL} (10 marks)
- (c) The air-gap power P_{AG} (10 marks)
- (d) The power converted from electrical to mechanical form P_{conv} (10 marks)
- (e) The induced torque τ_{ind} (10 marks)
- (f) The load torque τ_{load} (10 marks)
- (g) The overall machine efficiency (10 marks)

04)

I. What is Leakage flux in a transformer? Why is it modeled in a transformer equivalent circuit as an inductor?

(10 marks)

II. Draw the transformer phasor diagram for

- a. θ Leading power factor
- b. Unity power factor.
- c. θ Lagging power factor.

(15 marks)

III. A 1 kVA, 230/115 V transformer has been tested to determine its equivalent circuit. The results of the tests are shown below.

Reading	Open-circuit test	Short-circuit test
Voltmeter	$V_{oc} = 230 \text{ V}$	$V_{sc} = 19.1 \text{ V}$
Ammeter	$I_{oc} = 0.45 \text{ A}$	$I_{sc} = 8.7 \text{ A}$
Wattmeter	$P_{oc} = 30 \text{ W}$	$P_{sc} = 42.3 \text{ W}$

- a) Find the equivalent circuit of this transformer with reference to high-voltage side
(15 marks)
- b) Find the equivalent circuit of this transformer with reference to low-voltage side
(15 marks)
- c) Draw the equivalent circuit of the transformer with reference to the secondary side
(15 marks)
- d) Find the full load current on the secondary side of the transformer.
(15 marks)
- e) Calculate the voltage regulation at 0.8 power factor lagging
(15 marks)