Uva Wellassa University, Sri Lanka
Faculty of Science and Technology
Science and Technology Degree Program
2nd Semester Examination – September / October 2013

SCT 369-2 Electric Power and Machines

Number of questions: three (03)
Answer all questions
Time allocation: Two (02) hour
Total marks allocated: 100
All symbols used have their standard definitions

1.

a. Explain how a shunt DC motor responds to an increasing external load.

(03 marks)

b. A 50 hp, 250 V, 1200 rad/min DC shunt motor with compensating windings has an armature resistance (including brushes, compensating windings and interpoles) of 0.06 Ω. Its field circuit has a total resistance $R_{adj} + R_f$ of 50 Ω, which produces no-load speed of 1200 rad/min. There are 1200 turns per pole on the shunt field winding. Determine the speed of this motor when its input current is,

i. 100 A.
ii. 200 A.
iii. 300 A.

(12 marks)

c. A separately-exited generator develops a no-load e.m.f. of 150 V at an armature speed of 20 rev/sec and a flux per pole of 0.10 Wb. Determine the generated e.m.f. when,

i. the speed increases to 25 rev/sec and pole flux remains unchanged
ii. the speed remains at 20 rev/sec and the pole flux is decreased to 0.08 Wb
iii. the speed increase to 24 rev/sec and the pole flux decreased to 0.07 Wb

(15 marks)



15

2.

a. The secondary winding of a transformer shown in Figure 1 has a terminal voltage of $V_s$ (t) = 282.8 sin 377t V. The turns ratio is 100:200. The secondary current of the transformer is, $i_s$ (t) = 7.07 sin (377t – 36.87°) A. The impedances of this transformer referred to the primary side are

$R_{eq} = 0.20\ \Omega$ $\quad R_c = 300\ \Omega$

$X_{eq} = 0.750\ \Omega$ $\quad X_M = 80\ \Omega$

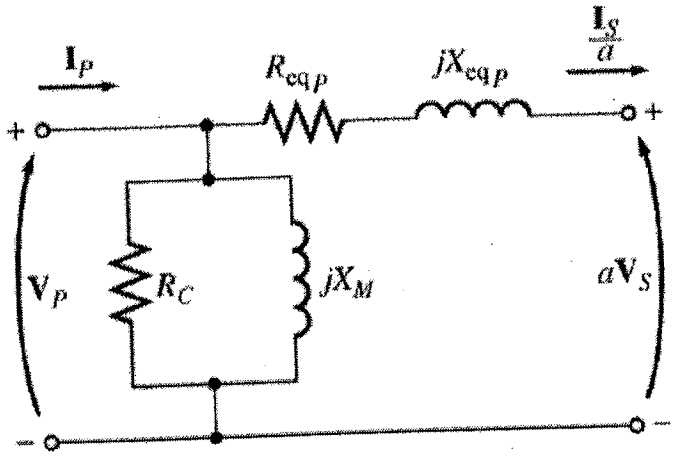


Figure 1: Approximate equivalent circuit of the transformer referred to the primary side

Determine the followings,

i. the primary current of the transformer.
ii. voltage regulation of the transformer.
iii. input power of the transformer.
iv. output power of the transformer.
v. efficiency of the transformer.

(25 marks)

b. A single phase auto transformer has a voltage ratio of 320 V: 250 V and supplies a load of 20 kVA at 250 V. Assuming an ideal transformer, determine the followings,

i. draw an appropriate model for the above auto transformer
ii. calculate the current in each section of the winding

(10 marks)

3.

a. Explain how induction torque is generated in an induction motor.

(03 marks)

b. A three-phase, 60 Hz induction motor runs at 890 rad/min at no load and at 840 rad/min at full load. Determine the followings,

i. number of poles in this motor.
ii. the slip at rated load.
iii. the speed at one-quarter (1/4) of the rated load.
iv. the electrical frequency of the rotor at one-quarter (1/4) of the rated load.

(12 marks)

c. A 208 V, 60 Hz Y connected wound rotor induction motor is rated at 15 hp. Its circuit components are

$R_1 = 0.200\ \Omega$ $R_2 = 0.120\ \Omega$ $X_M = 15.0\ \Omega$

$X_1 = 0.410\ \Omega$ $X_2 = 0.410\ \Omega$

$P_{mech} = 250\ W$ $P_{misc} = 0$ $P_{core} = 180\ W$

For a slip of 0.05 calculate the followings,

i. the line current, $I_L$.
ii. the stator copper losses, $P_{SCL}$.
iii. the air gap power $P_{AG}$.
iv. the power converted from electrical to mechanical form, $P_{CONV}$.
v. the induced torque, $\tau_{ind}$.
vi. the load torque, $\tau_{load}$.
vii. the overall machine efficiency.
viii. the motor speed in rev/min and rad/sec.

(20 marks)



15