Uva Wellassa University of Sri Lanka
Faculty of Science and Technology
Science and Technology Degree Programme
3rd Year 2nd Semester Examination – August/September 2014

SCT 369-2 Electric Power and Machines

Number of questions: Four (04)
Answer all questions
Time allocation: Two (02) hours
Total marks allocated: 100

1.

a. A 12 pole DC generator has a simplex wave-wound armature containing 144 coils of 10 turns each. The resistance of each turn is 0.011 Ω. Its flux per pole is 0.05 Wb, and it is turning at a speed of 200 rpm. Determine the following.

i. Number of current paths.
ii. Induced armature voltage of the machine.
iii. Effective armature resistance.
iv. If a 1 kΩ resistor is connected to the terminals of this generator, what will be the resulting induced counter-torque on the shaft of the machine? (Ignore the internal armature resistance of the machine)

(15 marks)

b. The magnetization curve for a separately excited dc generator is shown in Fig 1.1. The generator is rated at 6 kW, 120 V, 50 A, and 1800 rpm and is shown in Fig 1.2. Its field circuit is rated at 5A. Assuming no armature reaction determine the following about this generator.

i. If this generator is operating at no load, what will be the range of voltage adjustments that can be achieved by changing R_{adj}?
ii. If the field rheostat is allowed to vary from 0 to 30 Ω and the generator's speed is allowed to vary from 1500 to 2000 rpm, what will be the maximum and minimum no load voltages in the generator?

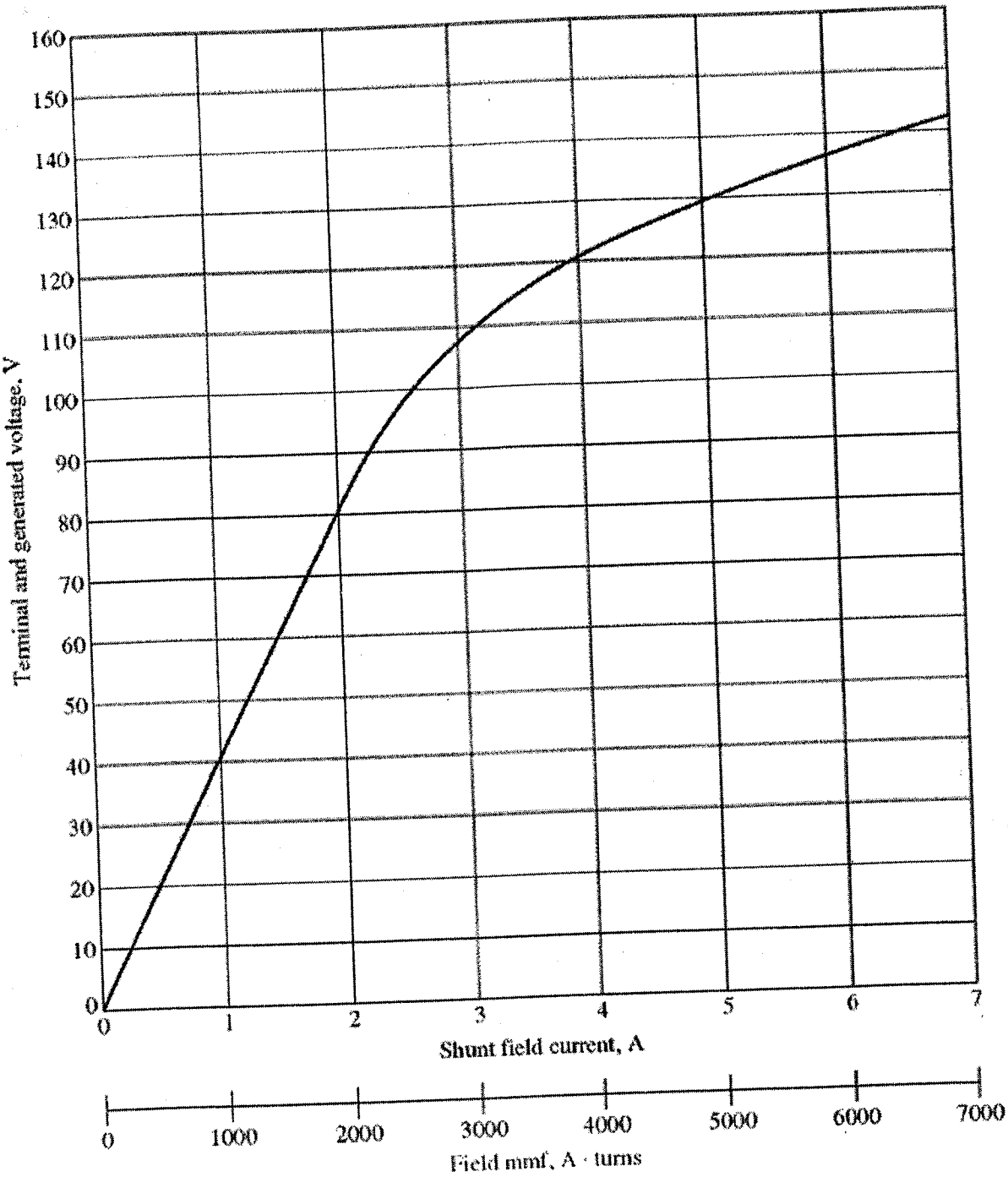
Terminal and generated voltage, V
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
0
1
2
3
4
5
6
7
Shunt field current, A
0
1000
2000
3000
4000
5000
6000
7000
Field mmf, A · turns

Fig. 1.1

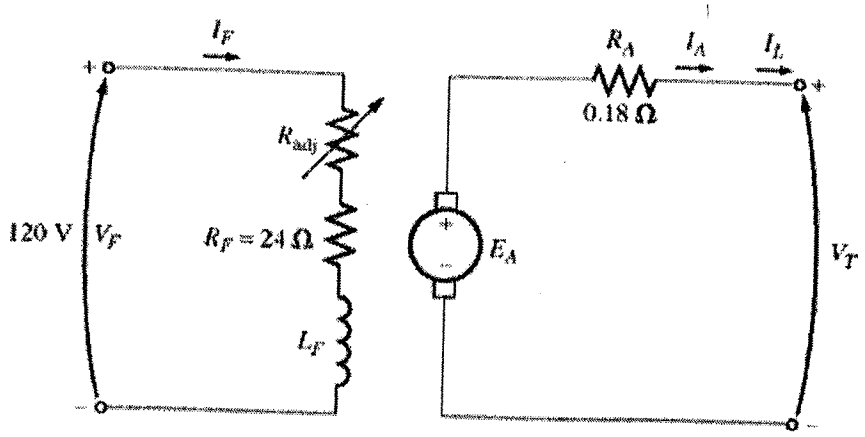

Fig. 1.2

$R_A = 0.18\ \Omega$ $R_{adj} = 0$ to $30\ \Omega$ $V_F = 120$ V

$R_F = 24\ \Omega$ $N_F = 1000$ turns per pole

(10 marks)

2. A 20 kVA 8000/480 V distribution transformer has the following resistances and reactances.

$R_P = 32\ \Omega$ $R_S = 0.05\ \Omega$

$X_P = 45\ \Omega$ $X_S = 0.06\ \Omega$

$R_C = 250\ k\Omega$ $X_M = 30\ k\Omega$

The excitation branch impedances are given referred to the high-voltage side of the transformer.

a. Find the equivalent circuit of this transformer referred to the high-voltage side.

(06 marks)

b. Find the per-unit equivalent circuit of this transformer.

(07 marks)

c. Assume that this transformer is supplying rated load at 480 V and 0.8 PF lagging. What is this transformer's input voltage? What is its voltage regulation?

(07 marks)

d. What is the transformer's efficiency under the conditions of part (c)?

(05 marks)

3.

a. An induction motor is running at the rated conditions. If the shaft loas is now increased, how do the following quantities change? Briefly explain your answers.

i. Mechanical speed
ii. Slip
iii. Rotor induced voltage
iv. Rotor current
v. Rotor frequency
vi. Rotor copper loss
vii. Synchronous speed

(14 marks)

b. A two pole 50 Hz induction motor supplies 20 hp to a load at a speed of 2950 rpm. If the mechanical losses of the motor are zero, determine,

i. the slip of the motor. (02 marks)
ii. induced torque in the motor. (03 marks)
iii. the operating speed of the motor if its torque is doubled. (03 marks)
iv. the power supplied by the motor when the torque is doubled. (03 marks)

4.

a. How can the magnetomotive force and flux distribution in an AC machine be made more nearly sinusoidal? Briefly explain your answer.

(10 marks)

b. The following information is known about the simple two pole AC generator. The peak flux density of the rotor magnetic field is 0.2 T, and the mechanical rate of rotation of the shaft is 3600 rpm. The stator diameter is 0.5 m, its coil length is 0.3 m, and there are 15 turns per coil. The machine is Y-connected. Determine the following,

i. Three phase voltages of the generator as a function of time
ii. rms phase voltage of this machine.
iii. rms terminal voltage of this machine.

(.15 marks)