UNIVERSITY OF RUHUNA

Faculty of Engineering

Mid-Semester 3 Examination in Engineering: June 2015

Module Number: EE3304 **Module Name: Electric Machines**

[Two Hours]

[Answer **all questions**, Q1 and Q2 carry **5 marks** and Q3 carries **10 marks**]

Q1 a) i) What are the types of losses occurred in a magnetic core in electric machines?

ii) Explain the methods that can be employed to reduce the core losses in an electric machine.

[1 Mark]

b) A ferromagnetic material of the core shown in Figure Q1.a has the relative permeability of 800. The dimensions of the core are as shown in the figure. Find the value of the current i that requires to produce a flux density of 0.5 Wb/m^2.

[2 Marks]

c) Assume that the core shown in Figure Q1.a has the magnetic flux as shown in Figure Q1.b. Sketch the voltage induced across the terminals of the winding e_{ind}.

[2 Marks]

Q2 a) Draw the equivalent circuit of a single phase transformer. Define each element you used and mention what they are representing.

[1 Mark]

b) A single-phase power system consists of a 480 V, 50 Hz, generator supplying a load $Z_{Load} = 4 + j3\ \Omega$ through a transmission line of impedance $Z_{Line} = 0.18 + j0.12\ \Omega$ as shown in Figure Q2. Calculate the load voltage, transmission line loss and the overall efficiency of the system.

[2 Marks]

c) Suppose a 1:10 step-up ideal transformer is placed at the generator end of the transmission line and a 10:1 step-down ideal transformer is placed at the load end of the line in the single phase power system mentioned in b). Calculate the load voltage, transmission line loss and the efficiency of the overall system and compare with results obtained in part b).

[2 Marks]

Q3 A DC machine has the following parameters.

$R_A = 0.18\ \Omega$ $I_{rated} = 110$ A $R_{adj} = 150\ \Omega$ to $400\ \Omega$

$N_F = 2700$ $R_F = 75\ \Omega$ R_{adj} is connected in series with the field winding

Rated speed of the machine is 1800 rev/min and its open circuit characteristics is shown in Figure Q3.

a) i) The machine is connected as a separately excited DC generator and the field circuit is supplied by a 240 V external DC source. If the generator is allowed to operate up to 2000 rev/min, find the maximum no load voltage that can be obtain from the generator.

ii) If the generator rotates at 1800 rev/min and supplies 100 A load current, calculate the value of the adjustable field resistor R_{adj} to make the terminal voltage 240 V.

iii) If the machine is connected as shunt generator with R_{adj} of 175 Ω, what will be the no load terminal voltage when the machine is turning at its rated speed? Assume that the voltage drop across the R_A is negligible.

[5 Marks]

b) Assume that the above machine is operated as a shunt DC motor with a supply voltage of 240 V and R_{adj} with 175 Ω.

i) Calculate the no load speed.

ii) At full load, machine draws a line current of 110 A. Calculate the motor's speed at full load and hence calculate the speed regulation. Neglect the armature reaction.

iii) If the armature reaction of the motor at full load is equal to 1000 A.turns, what will be the speed of the motor at full load?

[5 Marks]

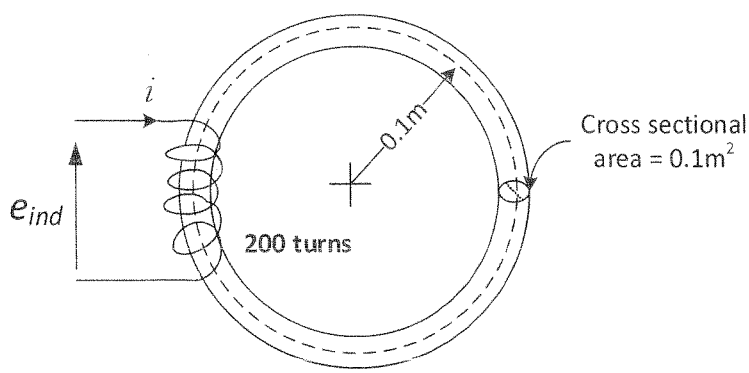

Figure Q1.a

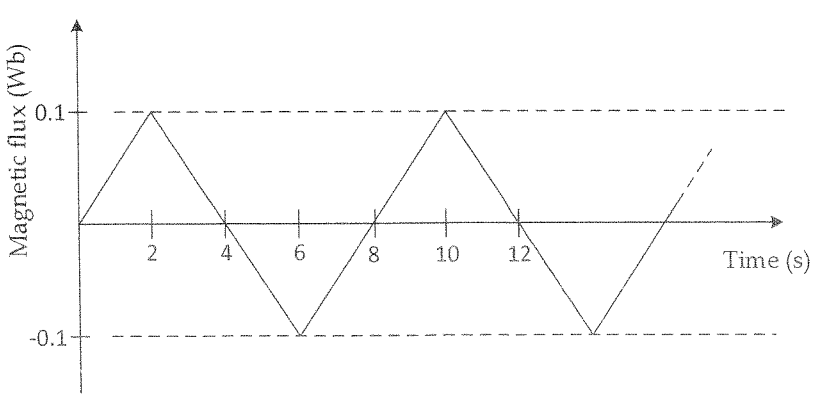

Figure Q1.b

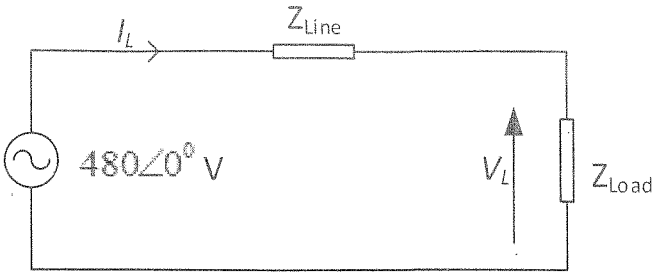

Figure Q2

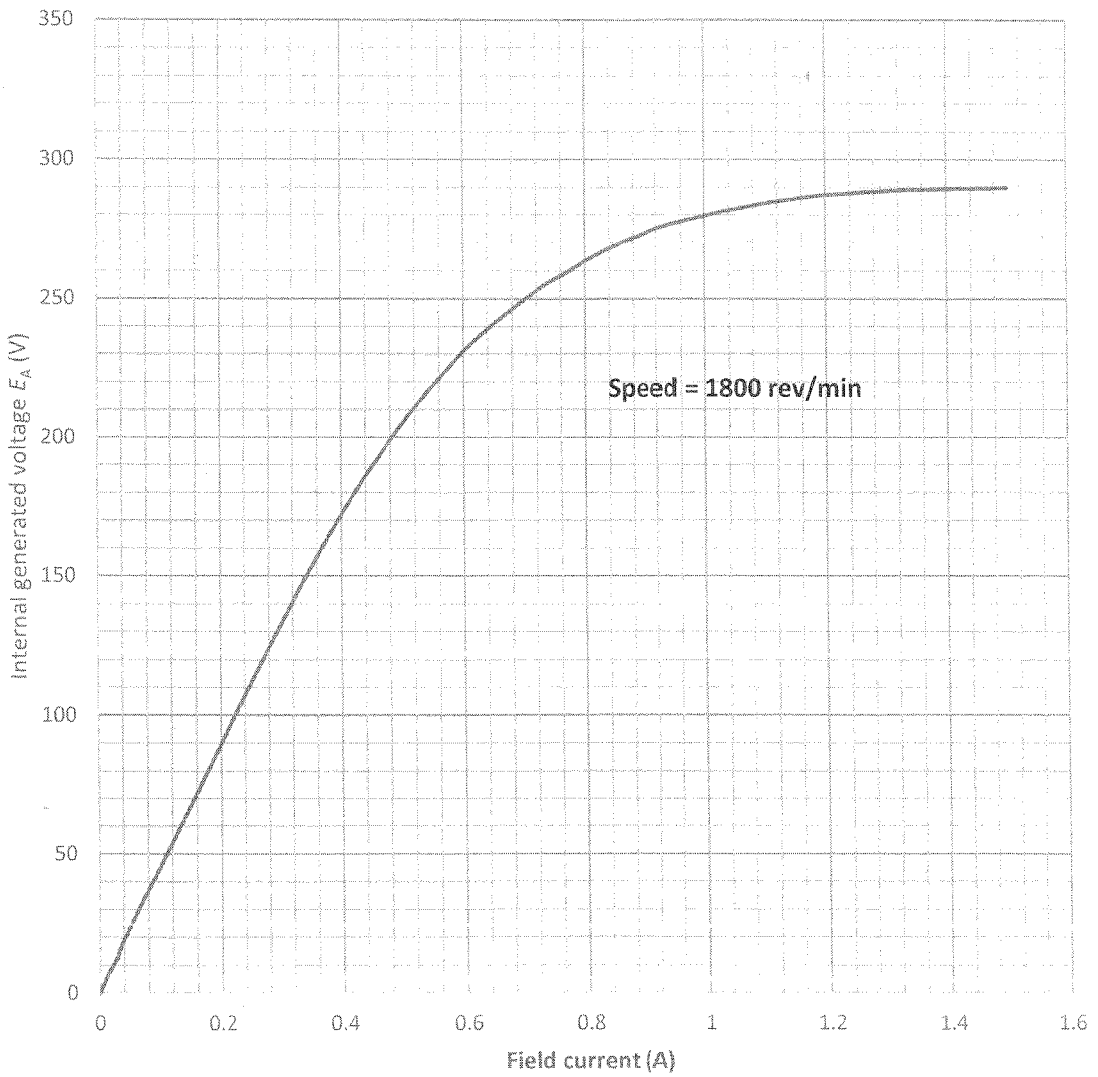

Figure Q3

Note: Detach this page and attach with your answer script.