COLLEGE OF ENGINEERING & TECHNOLOGY

Department: Electrical & Control Engineering

Lecturer: Prof. Dr. Adel Metawee

Course: Electrical Machines (1) **Marks: 40**

Course Code: EE231

Date: 21/1/2015 **Duration: 2 hours**

Final Examination Paper

Answer 4 Questions ONLY:

Question (1):

Consider an elementary rotating reluctance machine with 4 rotor poles instead of two. The poles are so shaped that the reluctance of the magnetic system is given by:

$$R(\theta) = 3*10^5 - 2*10^5 \cos 4\theta \qquad A.T/wb$$

The stator coil has 120 turns and negligible resistance. An ac voltage of 115 V (RMS) at 50 Hz is applied to the coil terminals:

a. Find the value of minimum and maximum reluctance.
b. Determine the synchronous speed of the rotor
c. Determine the maximum average torque that the machine can develop.

Assume that: $\theta(t) = \omega mt - \delta$ [10 Marks]

Question (2):

a. Use illustrative drawing to explain the construction of a 4 pole DC machine and ***indicate on your drawing*** the location of the following:
   - a- Poles
   - b- Field windings
   - c- Brushes and commutator
   - d- Armature windings [4 Marks]

b. Design a suitable lap winding for a dc armature with 8 slots each containing 2 coil sides. Winding is double layer and number of poles is 4.

   i. Determine the number of coils, slot span, back pitch, forward pitch and commutator pitch.
   ii. Draw 3 coils at least showing the position of the brushes and the number of parallel paths. [6 Marks]

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Question (3):

a. Plot the external characteristics of a dc shunt generator, and state the main reasons for the voltage failure of shunt excited generators under loading conditions.

[4 Marks]

b. The open circuit characteristics for a 4 pole, 1000 rpm, shunt generator is as given by:

Field current (A)	0	0.5	1	1.5	2	2.5	3
O.C. voltage (V)	5	50	85	102	112	116	120

The armature is lap-connected with 144 conductors. The Field resistance is 45 Ω. Determine:

i. The voltage to which the machine will build up at no load
ii. The critical field resistance
iii. The speed to which the machine just fails to excite.
iv. The residual flux per pole
v. The additional resistance required so that the machine builds up at 95 V.

[6 Marks]

Question (4):

a. Compare between series and shunt motor from points of view of:
   i. Circuit configuration
   ii. Governing equations
   iii. Torque-speed characteristics [3 Marks]

b. A 250 V shunt motor has a total armature circuit resistance of 0.25 Ω and a field circuit resistance of 200 Ω. At no load and rated voltage, the speed is 1200 rpm and the line current is 4.5 A. At full load and rated voltage, the line current is 65A. Assume the field flux to be reduced by 6% from its value at no load due to the effect of armature reaction. Compute the full load speed.

[7 Marks]

Question (5):

a. Discuss briefly the methods of speed control in DC motors. [2 Marks]

b. A 250 V shunt motor takes a current of 5 A at no load. The armature circuit resistance is 0.2 Ω and the shunt field winding resistance is 100 Ω. When the motor operates at full load at 2500 rpm. It takes 25 A. Determine:
   i. The efficiency at full load.
   ii. The no load speed. [8 Marks]

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