الهندسة الكهربية

Mansoura University.
Faculty of Engineering.
Electrical Engineering Dept.

Second Semester.
Date: 25/5/2013
Time: Three Hrs./Two-parts
Full Mark: (55)

Final-Term Exam of (Electrical Machines I)
For 2nd Grad Electrical Engineering Dept. students.

الامتحان من جزأين: من فضلك أجب كل جزء من الامتحان في اتجاه مختلف من ورقة الإجابة.

Answer the following questions and assume any missing data: **Part (I)**

Question № (1): (5+10 Marks)

1-1) ***Numerate*** the different types of dc. machines? ***Draw*** the circuit diagram and ***write*** the voltage equation of each type as motor and generator and ***compare*** their external characteristics.

1-2) ***Calculate*** the ampere-turns required for the tooth of dc. armature with the following dimensions:

Armature diameter = 656.3 mm; № of slots = 72 slots;
Core-outer diameter = 634.3 mm; Slot-width = 10 mm with parallel sides;
Slot pitch flux = 10.715 mWb Armature gross length = 350 mm;
№ of ventilating ducts = 5 each 1 cm wide; Iron space factor = 0.89.

The magnetization B-H curve for the material used is given by:

$$B = 3.77\times10^{4}H^{4} - 2.86\times10^{5}H^{3} + 8.12\times10^{5}H^{2} - 1.03\times10^{6}H + 4.86\times10^{5}$$

Question № (2): (5+10 Marks)

2-1) ***Explain*** clearly the reasons for the fall in terminal voltage of a dc. shunt generator as it is loaded. ***What*** modifications are necessary to compensate the voltage drop due to load and feeder?

2-2) The following data pertain to the magnetization curve of a D.C. shunt generator at 1500 r.p.m.

I_f [A]	0	0.4	0.8	1.2	1.6	2.0	2.4	2.8	3.0
E_a [V]	6	60	120	172.5	202.5	221	231	237	240

For this generator, ***obtain***:

(a) The voltage on open circuit which the machine will build up for a total shunt field resistance of 100 Ω.
(b) The critical value of shunt field resistance at 1500 r.p.m.
(c) The critical speed for the shunt field resistance of 100 Ω.
(d) The terminal voltage of the generator if the total armature resistance is 0.3 Ω, armature current is 50 A and the speed is 1500 r.p.m. Neglect armature reaction.
(e) The external characteristic, maximum armature current and short circuit current.

Question № (3): (5+5+5 Marks)

3-1) ***Discus*** the power flow inside dc machine, and deduce the efficiency equation. At what load does maximum efficiency occur?

3-2) ***Draw*** a neat diagram of a three-point starter, ***label*** its parts, and explain how it works. Also ***explain*** its defect and the protective devices therein.

3-3) A 4-pole, 250 V, 7.5 KW (output), wave-connected shunt motor has an armature resistance of 0.4 Ω and a field resistance of 125 Ω. ***Estimate*** the current taken by the motor on no-load if the full-load efficiency of the motor is 86%.

Mansoura University

Faculty of Engineering — **Second Year Exam.**
Electrical Eng. Dept. — **Time: 1.5 Hours**

"ELECTRIC MACHINE FINAL-TERM EXAM PART (1)-2013"

ANSWER FOUR QUESTIONS OF THE FOLLOWING:

1) (a) From the principle derive the transformer equivalent circuit parameters.

(b)A 20 KVA , 2200/220 V ,50 Hz, single-phase transformer has the following equivalent circuit parameters referred to the high potential terminals

of the transformer. $R_1 = 2.51\ \Omega$, $R_2 = 3.11\ \Omega$, $X_m = 25100\ \Omega$, $X_1 = 10.9\ \Omega$, $X_2 = 10.9\ \Omega$.

The transformer is supplying 15 KVA, 220 Volt at lagging power factor of 0.85. Draw the approximate equivalent circuit with its parameter values and determine;

a) the primary potential difference required;
b) the power factor at the primary terminals ;
c) the transformer maximum regulation ;
d) the transformer maximum efficiency if the constant losses= 900 watt ;
e) draw the vector diagram with voltage scale 1:100 . [14 pts]

2) (a) Draw the magnetizing current waveforms at no-load during the transient and steady- state periods. Derive the expression required to explain its nonlinearity.

(b) Three 10 KVA, 1330/250 V,50 Hz single-phase transformers are connected in star/ delta to form 3-phase transformer bank to supply at 250 volts line-to-line a heating load of 2 KW per phase and a three-phase load of 23 KVA at 0.8 lagging power factor. Determine the line current supplying the transformers, and the voltage regulation in the following both cases;

(i) the three single-phase transformers are considered ideal;

(ii) each one of the three single-phase transformer impedance is 0.118+j0.238 referred to low-potential side. However, the loads are connected to the 3-phase transformers bank by means of a common three-phase feeder whose impedance is 0.003+j0.010 Ω per phase. Moreover, the 3-phase transformers bank themselves are supplied from a constant- potential source by means of a three-phase feeder whose impedance is 0.75+j 5.0 Ω, per phase. [14 pts]

3) (a) Discuss and drive all the expressions required to illustrate the transformer operation under the variable frequency source.

(b) the equivalent circuit parameters of the audio transformer are as following:

$R_1 = 4\ \Omega$, $R_2 = 0.40\ \Omega$, $L_m = 35$ mH, $L_{l1} = 0.4$ mH, $L_{l2} = 0.045$ mH, $N_1/N_2 = 5$.

The speaker resistive load = 4 Ω is connected to the transformer