Menoufiya University *Faculty of Engineering – Shebin El-Kom* *First Semester Examination* *Academic Year: 2015-2016* *Date: 31/12/2016*	*Year: 2016* *Department: Electrical Engineering* *Subject: Theories of Electrical Machines* *Code: ELE 602* *Diploma One* *Time Allowed: 3 hours*

Allowed Tables and Charts: None

Part "1": Three – Phase Transformers, 50 Marks

Question 1 (10 Marks):

(a) Explain clearly how a three – phase transformer $(Y/\Delta-11)$, group number 4, can be successfully operated in parallel with another three – phase transformer $(\Delta/Y-1)$, group number 3.

Question 2 (10 Marks):

Two Δ/Y 11000/400 V transformers are to be operated in parallel. Their primaries in delta are energized from the same supply mains of 11 kV. The secondary terminals are marked $a_2 b_2 c_2$ for one transformer and $a_2' b_2' c_2'$ for the second transformer. (a) If terminals a_2 and a_2' are connected together, then the voltmeters connected across: $b_2 b_2'$, $c_2 c_2'$, $c_2 b_2'$ and $b_2 c_2'$ give the following readings: $V_{b_2 b_2'} = V_{c_2 c_2'} = 800\text{ V}$ and $V_{c_2 b_2'} = V_{b_2 c_2'} = 693\text{ V}$. If secondary neutrals are not connected, explain, by means of phasor diagrams, how this happens. (b) Now terminals a_2 and a_2' are disconnected, but their neutrals are joined together. Calculate the voltages: $V_{a_2 a_2'}$; $V_{b_2 b_2'}$; and $V_{c_2 c_2'}$. (c) Explain how these two transformers can be operated in parallel.

Question 3 (10 Marks):

(a) What are the disadvantages of harmonics in transformers? (b) Two 3 - phase transformers, rated at 500 kVA and 450 kVA respectively, are connected in parallel to supply a load of 1000 kVA at 0.8 pf lagging. The per phase resistance and per phase leakage reactance of the first transformer are 2.5% and 6% respectively and of the second transformer are 1.6% and 7% respectively. Calculate the ***kVA load*** and power factor for each transformer.

Question 4 (10 Marks):

A three – phase Y/Δ transformer has its delta open – circuited as shown in *Figure Q4*. A voltmeter placed across phase winding *ab* reads 260 V and when placed across open – circuited delta, it reads 300 V. Find the reading of the voltmeter if it is placed across terminals *bc* and *bd*. The odd harmonics, ***up to seventh harmonic***, are only to be considered.

Question 5 (10 Marks):

A bank of three identical unity – ratio transformers is connected as shown in *Figure Q5*. At no load, the readings on ammeter A_1 and A_2 are 0.75 A and 0.46 a respectively. (a) If the secondary is also connected in delta, what will happen to the readings of ammeters A_1 and A_2. (b) If the transformer is connected in Y/Δ, find the currents in the primary star and the secondary closed delta. (c) If the transformer is connected in Y/Y with four wire supply, calculate the current in the line and in the neutral wire. Consider harmonics, ***up to 7th order.***

Part "2": Energy Conversion and Dynamic Circuits, 50 Marks

Question 6 (10 Marks):

Consider the doubly – excited rotating system represented in *Figure Q6*. The stator coil is open – circuited and the rotor coil, which is excited from a constant current source, produces a sinusoidal spatial flux distribution. At the position $\theta = 0$, coil 1 experiences the maximum flux linkage of 10 Wbt. If the speed of the rotor is 314 rad/s, find the induced voltage at the terminals of coil 1.

Question 7 (10 Marks):

Consider the doubly – excited rotating system described in *Q6*, illustrated in *Figure Q6* and let the same considerations prevail except that $i_2 = I_{2\max} \sin \omega_m t$ and $\theta = 0$ at $t = 0$. Determine: (a) the instantaneous value of the motional and transformer induced *emfs* at the terminals of coil 1, (b) the frequency of alternation of coil 1 terminal voltage and, (c) the resultant average value of the coil 1 terminal voltage.

Question 8 (10 Marks):

Figure Q8 shows a cross – sectional view of a cylindrical solenoid. Coil excitation creates magnetic poles at the faces of air gap *x*. Calculate: (a) the magnetic flux in the plunger and (b) the circuit inductance. Use the following information: $a = 30\,mm$, $b = 60\,mm$, $c = 90\,mm$, $d = 60\,mm$, $e = 90\,mm$, $g = x = 1\,mm$, $i = 10\,A$, $N = 100\,turns$. Assume that the permeability of the iron is infinitely large and neglect leakage and fringing. (c) Would the force on the plunger reverse if the current direction were reversed? (d) Find the magnetic stored energy in terms of the geometry and the applied current. (e) What proportion of this energy is stored in the air gap of length *x*?

Question 9 (10 Marks):

The reluctance of the magnetic circuit of the reluctance machine can be expressed by Fourier series as: $\Re(\theta_m) = \Re_o + \Re_1 \cos(2\theta_m) + \Re_3 \cos 3(2\theta_m) + ---$

Prove that the average torque of the reluctance machine with ac excitation is: $T_{eav} = -\frac{1}{4}\Phi_{\max}^2 \Re_1 \sin 2\delta$, at the synchronous speed ω, and at the subsynchronous speed, where $3\omega_m = \omega$; $T_{eav} = -\frac{3}{4}\Phi_{\max}^2 \Re_3 \sin 6\delta$ assuming that δ is the rotor position at $t = 0$.

Question 10 (10 Marks):

A contactor, illustrated in *Figure Q10*, is energized from a constant 25 V dc source. The coil of 20 turns has a resistance of 5 ohms. Initially the air gaps are set such that $x = 10\,mm$ and in this position the flux per ampere turns is 0.2 mWb/At. Leakage, fringing, and the reluctance of the iron are neglected. The armature is allowed to move very slowly through a distance of 5 mm in the direction of the electromagnetic force. Determine the mechanical work done and the electric energy, in excess of (الزائدة عن) the heat dissipated in the coil that is provided by the source due to the motion.

Please see the attached Figures

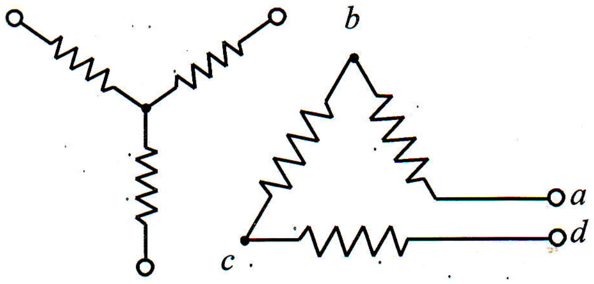

Figure Q4

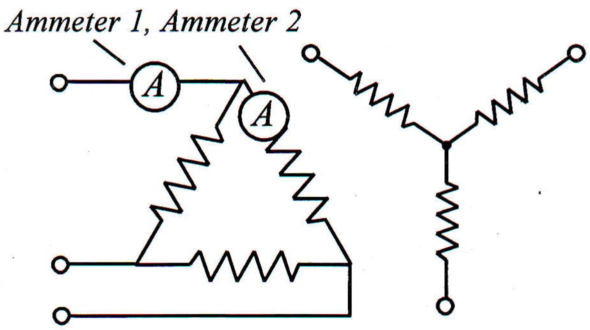

Figure Q5

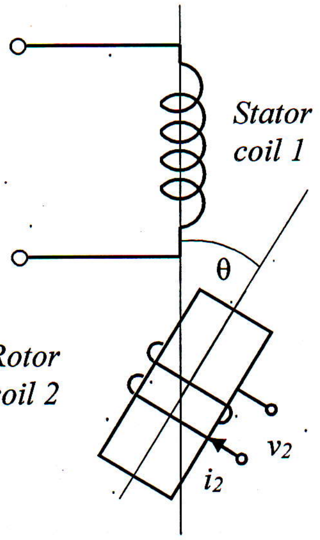

Figure Q6

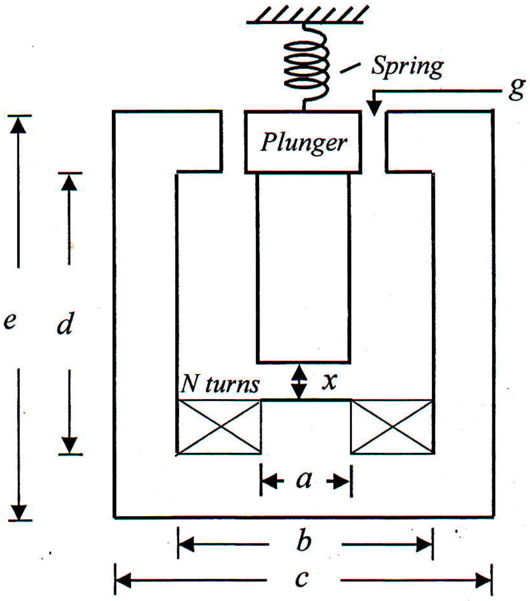

Figure Q8

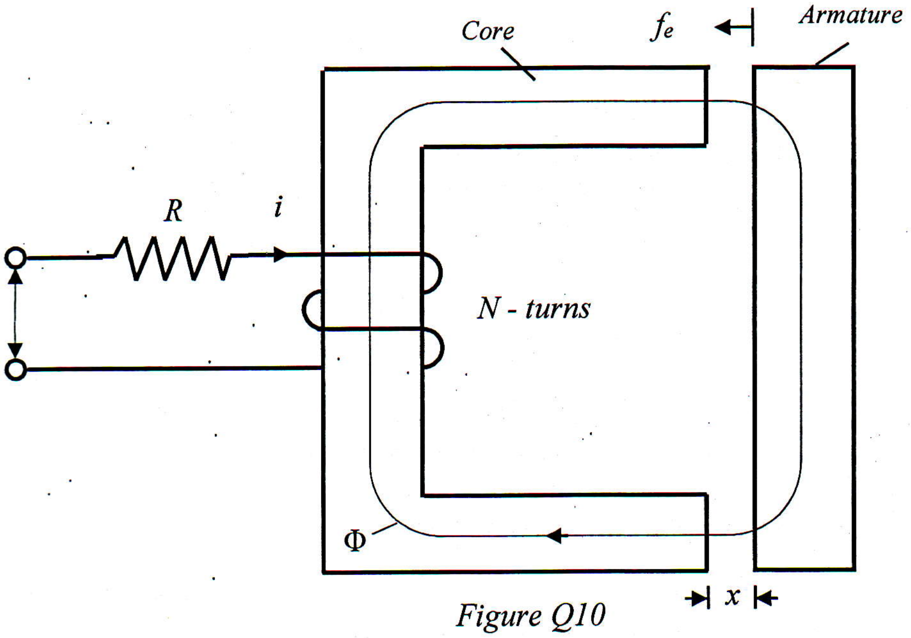

Figure Q10

Good Luck Every One