Electrical Technology (EE11001)
Department of Electrical Engineering

End Semester (Spring) **Date: 28th April, 2017** **No. of students: 686**
Full marks – 100 **Duration – 3 hours**

Answer any five.

Indicate the question attempted by putting a tick mark on the question number given in the cover page of the answer script.

Q1. (a) Calculate the form factor and peak factor of the periodic waveform shown in Fig Q1(a). **[5]**

(b) Using Thevenin's theorem and Y/Δ transformation find the current through the galvanometer, shown in Fig. Q1(b), where L_1= 48mH, R_1 = 33Ω, R_2 = R_3 = 100Ω, L_2 = 47mH, R_4=31Ω, R_g= 5Ω and R_s= 4Ω. **[15]**

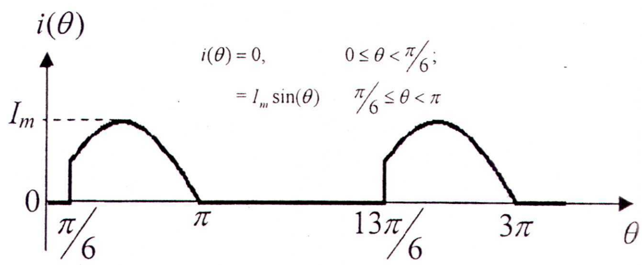


Fig. Q1(a)

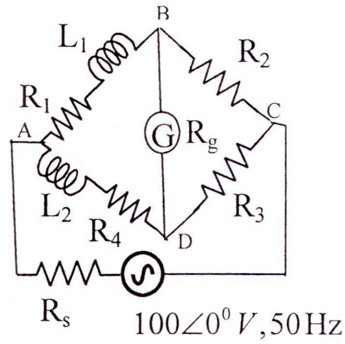


Fig. Q1(b)

Q2. (a) A star connected 3-phase induction motor, runs at 720 rpm at rated voltage from a 50 Hz 3-phase supply and develops a gross mechanical power of 15 kW. At this load, input power factor = 0.8, total mechanical power loss = 1.05 kW and total stator loss = 1.02 kW. Calculate
(I) slip, (II) total rotor copper loss, (III) air gap power, (IV) frequency of rotor voltage and rotor current and (V) current drawn from the supply. **[5x2 = 10]**

(b) A 10 kVA, 2500/250V, single phase transformer gave the following test results;

Open Circuit (OC) Test: 250 V; 2 A; 55 W;
Short Circuit (SC) Test: 60 V; 4 A; 60 W;

(I) Identify the sides from which the OC and SC tests have been carried out. **[1]**
(II) Compute the parameters of the approximate equivalent circuit referred to HV side and LV side respectively. Draw the approximate equivalent circuit and insert all the parameter values (i) referred to HV side and (ii) referred to LV side. **[2x2 = 4]**
(III) Find the voltage regulation at rated load at power factor 0.6 (lagging). **[2]**
(IV) Find the load and power factor at which maximum efficiency occurs and also value of the maximum efficiency at a power factor of 0.8 (lagging). **[2+1]**

Q3. (a) A sinusoidal voltage source $v(t) = 10\sin(314t)V$ is applied at t = t_1 to an initially relaxed series *R-C* circuit where $R = 100\Omega$ and $C = 18.387\,\mu F$. Derive the expression of the circuit current for $t \ge t_1$. Find the minimum value of t_1 (t_1> 0) for which there will be no transient in the circuit. **[5+3]**

(b) A balanced three phase load having per phase impedance of $(13.5 + j27)\Omega$ is supplied from a three phase balanced 45kV (r.m.s.) source through a line of impedance $(0.5 + j3)\Omega$ as shown in Fig. Q3(b). Three ideal wattmeters, connected as shown in Fig. Q3(b), give readings W_1, W_2 and W_3. Find $W_1 + W_2 + W_3$ and the total line loss. Consider R-Y-B phase sequence. **[9+3]**

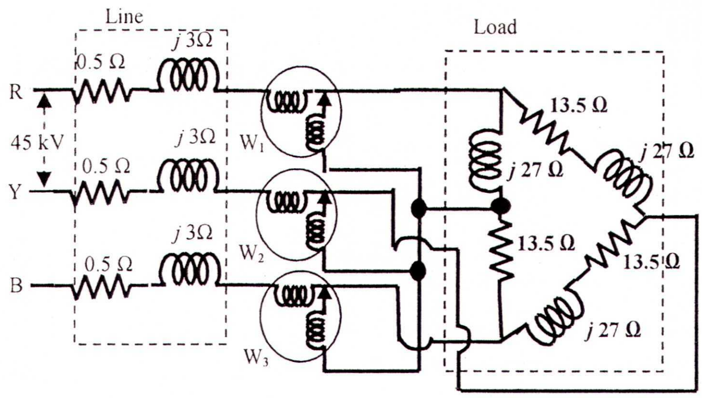


Fig. Q3(b)

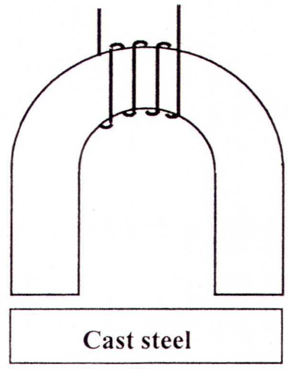


Fig. Q4(a)

Q4. (a) The cast steel electromagnet (shown in Fig. Q4(a)) has a cross sectional area of 25 cm^2. A cast steel bar is separated from the electromagnet by a distance of 1 mm. The steel path (electromagnet + bar) has a total mean length of 100 cm, and the coil on the electromagnet has 400 turns. The *B-H* relationship of cast steel is given below. Consider the relationship to be linear between any two consecutive data points.

Flux density (T)	0.9	1.1	1.2	1.3
Magnetic field strength (AT/m)	250	450	600	840

Find the current in the coil for maintaining the flux density in the air gap at 1.12 T. Also find the inductance of the coil. Neglect the effect of fringing and leakage. **[5+3]**

(b) For the transformer shown in Fig. Q4 (b), the load impedances connected are R_{AB} = 25 Ω and Z_{AC} = (15+*j*20) Ω. Number of turns between D-E is 100, between A-B is 150 and between B-C is 50. The leakage impedances of different parts of the windings are as given below.
Winding DE: (0.1 + *j*0.24) Ω; Winding AC: (0.4 + *j*0.96) Ω; Winding AB: (0.2667 + *j*0.64) Ω; The core loss of the transformer can be neglected and the relative permeability of the core material can be taken as infinite. Draw the equivalent circuit of the transformer including the load impedances, mentioning the parameter values and clearly marking the terminals A, B, C, D and E. If the induced e.m.f. in winding DE is 200 V then find the source voltage and the overall power factor of the transformer and loads. **[4+6+2]**

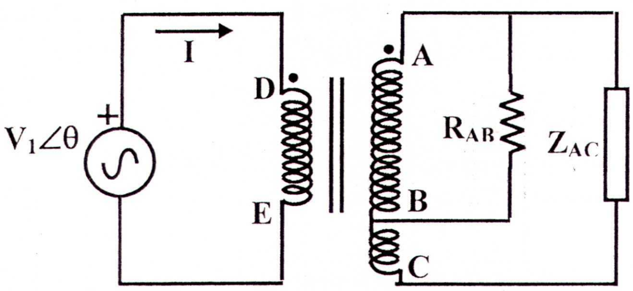


Fig. Q4(b)

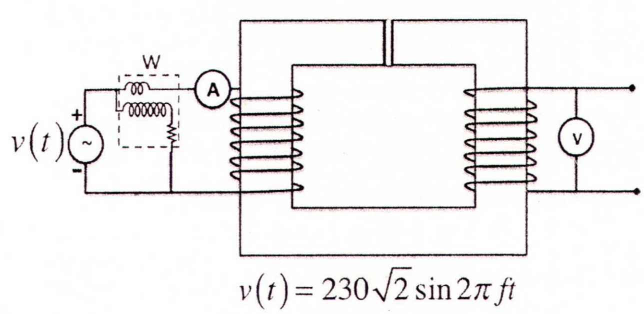
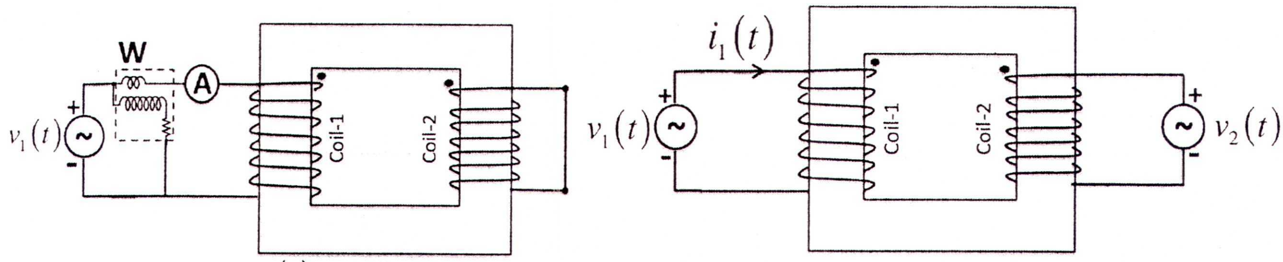


Fig. Q5(a)

Q5. (a) In the magnetic circuit shown in Fig. Q5(a) has a small air-gap. The readings of the wattmeter, ammeter and voltmeter are 70 W, 8 A, 125 V respectively when the r.m.s. supply voltage is 230 V at 50 Hz. Neglecting core-loss, find the readings of the meters when the supply frequency is increased to 100 Hz with supply voltage amplitude remaining same. **[10]**

Q5. (b) The figure (Fig. Q5(b)) shows a transformer with two identical windings. A short-circuit test is performed while connecting supply to coil-1 and shorting coil-2. The following readings were obtained: W=1000 W and I=31.62 A when $v_1(t) = 100\sin 100\pi t$ V. Find the time domain expression of the current $i_1(t)$ when the coil-1 and coil-2 are supplied with $v_1(t) = 100\sin 100\pi t$ V and $v_2(t) = 100\cos 100\pi t$ V respectively. Neglect the effect of no-load current.

[10]



$v_1(t) = 100\sin 100\pi t$ $\qquad$ $v_1(t) = 100\sin 100\pi t$ and $v_2(t) = 100\cos 100\pi t$

Fig. Q5(b)

Q6. (a) A 460-V, 4-pole, 50-hp, 60-Hz, star-connected, 3-phase squirrel-cage induction motor has the following equivalent-circuit parameters per phase.

$x_s = 0.42\Omega$	$x_r(standstill) = 0.42\Omega$	$x_m = 30\Omega$	$r_s = 0.0\Omega$

It drives stably a mechanical load with constant rated torque at 3.8% slip when operating at 60-Hz and 460 V. Mechanical, core, and stray losses may be neglected in this problem. Effective turns ratio of stator to rotor can be taken 1:1.

(I) Calculate the rotor resistance r_r.

(II) In order to improve the source power factor to unity, a three-phase star connected balanced capacitor bank is connected in parallel with this motor as shown in Fig. Q6(a). Find the value of per phase capacitor (in μF) required when the motor is operated with full load output torque. **[7.5+7.5]**

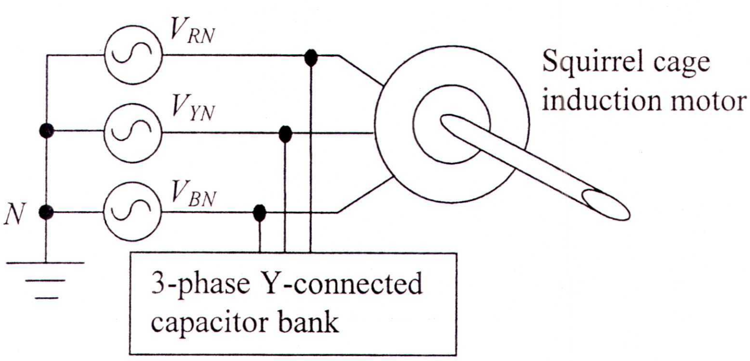


Fig. Q6(a)

(b) Explain the operation of a separately excited DC motor with a schematic diagram.

[5]

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