GP

Electrical Technology (EE11001)
Department of Electrical Engineering

Mid Semester (Spring) | **February, 2017** | **No. of students: 680**
Full marks – 100 | | **Duration – 2 hours**

Answer any five questions.

Q1. (a) Find the peak factor of the voltage signal $e(t) = E_m \sin(\omega t) + aE_m \sin(5\omega t)V$, where 'a' is a positive constant. **(4)**

(b) In the circuit, shown in Fig. Q1 (b), C is varying. Find the minimum value of the capacitive reactance such that the circuit will be operated at unity power factor. Draw to-scale phasor diagram on a graph paper of I, V, I_L, I_C, V_{R1}, V_{R2}, V_{XL} and V_{XC} when the circuit is operating at unity power factor. **(4+12)**

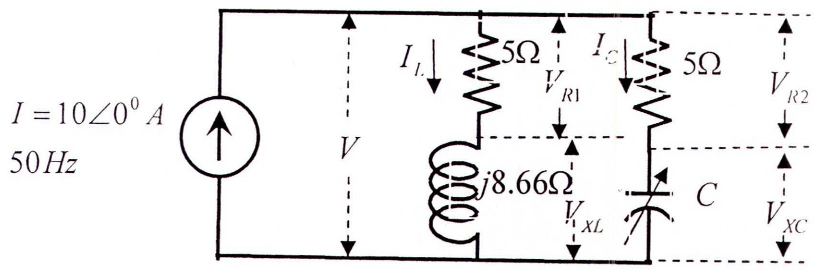

Fig. Q1 (b)

Q2. (a) For the circuit shown in Fig. Q2 (a), calculate the impedance $Z(j\omega)$. A sinusoidal current source $i_s(t) = 0.01cos(\omega t)$ A with variable frequency ω is connected between the terminals ab. Calculate the maximum possible rms current through the capacitor of 870 pF. Also calculate the corresponding value of ω. **(2+3+1)**

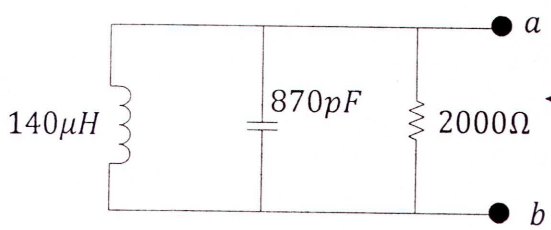

Fig. Q2 (a)

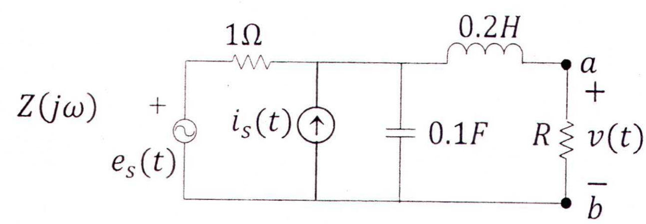

Fig. Q2 (b)

(b) The network shown in Fig. Q2 (b) is in steady state. $e_s(t) = 9cos(10t)$ V and $i_s(t) = 2\cos(10t - \pi/3)$ A.

(i) For the network on the left of the terminals ab (excluding R), obtain the Norton equivalent network.
(ii) Calculate a suitable value of R such that the average power drawn by R is maximum.
(iii) Derive the expression of instantaneous voltage $v(t)$ for this value of R.

(6+4+4)

Q3. (a) The four configurations of the connections of two linear active DC networks A (with terminals A1 and A2) and B (with terminals B1 and B2) are given in the Fig. Q3 (a). The values of I_1 , I_2 and I_3 are 16.5 A , 7.5 A and 1 A respectively. Find I_4. **(10)**

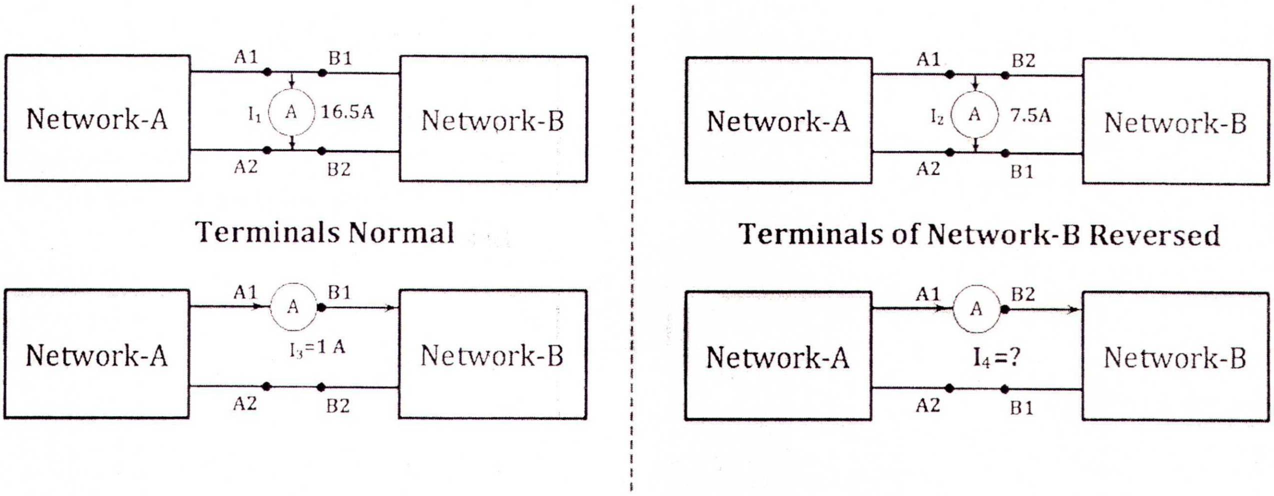

Fig. Q3 (a)

(b) In Fig. Q3 (b), find the values of ϕ $\left(0^0 \le \phi \le 90^0\right)$ for maximizing the active powers (i) P_1 and (ii) P_2. **(5+5)**

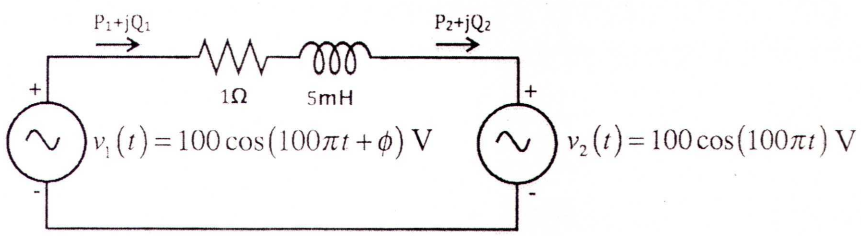

Fig. Q3 (b)

Q4. (a) In the circuit shown in Fig. Q4, the switch S was in neutral position (i.e., S is neither connected to position-1 nor to position-2) and the capacitor was uncharged. The switch is now moved to position-1 at t = 0. Write down the governing equation involving capacitor voltage v(t) and other parameters of the circuit. Get v(t) and the current through the capacitor i(t) and sketch them. What is the steady state voltage to which the capacitor will be charged? (2+4+2)

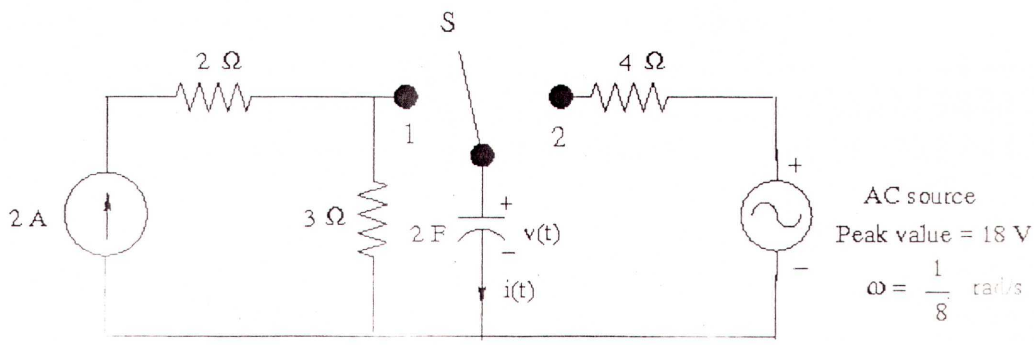

Fig. Q4

(b) Now assume that the circuit (Fig. Q4) reached steady state with S in position-1. The switch is now very quickly moved to position-2 at the instant when the a.c. supply voltage was at its positive peak. For this part of the problem, call this instant of switching to be t = 0. Derive the expressions for v(t) and i(t) for $t \geq 0$.

(8+4)

Q5. (a) Three single-phase voltage sources (V_a, V_b, V_c) are connected in delta to form a balanced three phase source. The values of two of these sources in volts are: $V_a = -20.92 - j239.09$ *and* $V_b = -196.6 + j137.66$; Find V_c (magnitude and phase) and identify the phase sequence. This three-phase source is used to supply two loads connected in parallel - one delta-connected and the other wye-connected. The total power supplied by the source is 8kVA at 0.6 power factor (lag) and the wye-connected load draws a total of 3 kW at unity power factor. Find the per phase impedance of the delta-connected load. **(1+2+5)**

(b) A balanced three-phase voltage source supplies a balanced three-phase delta-connected load through a transmission line having two equal segments (NM and MO), as shown in Fig. Q5. Each segment has a reactance of $j2\Omega$. The expression of the R-phase voltage $v_R = 240\sqrt{2}sin(100\pi t)$. Each phase of the balanced delta-connected load consists of a reactance of $-j84\Omega$with a current source in parallel, as shown in Fig. Q5. The source current connected between R and Y phase is $i_{RY} = 90\sqrt{2}sin(100\pi t)$. The phase sequence of both the sources is R-Y-B. Find the expression of the three line-to-line voltages at the mid-point (M) of the line. **(12)**

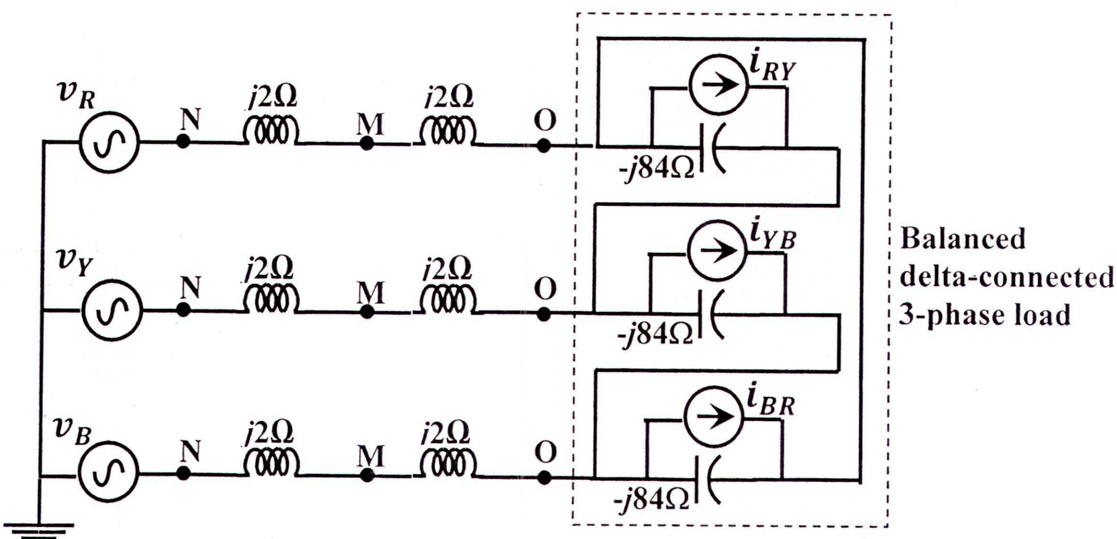

Fig.Q5

Q6. (a) A balanced delta-connected load having an impedance $Z_L = 300 + j210\ \Omega$ in each phase is supplied from 400 V, 3-phase supply (R-Y-B phase sequence) through a 3–phase line having an impedance of $Z_S = 4 + j8\ \Omega$ in each phase. The total power in the load is measured by means of two wattmeters with their current coils in lines R and B and their corresponding voltage coils across R and Y, and B and Y respectively. Calculate the reading on each wattmeter and the total power supplied to the load. **(15)**

(b) The current coil of a wattmeter is connected in series with an ammeter and an inductive load. A voltmeter and the voltage coil of the wattmeter are connected across a 400Hz supply. The ammeter, voltmeter, and wattmeter readings are 4.5A, 240V, and 29W respectively. The inductance and resistance of the voltage coil are 5mH and 4 kΩ respectively. If the voltage drops across the ammeter and current coil are negligible, what is the percentage error in wattmeter reading? **(5)**

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