Department of Electrical Engineering
Indian Institute of Technology, Kharagpur

Electrical Technology(EE11001) Date: 17th Sept., 2015 FN
1st Year Exam Halls: F116, F142, S301, S302, V1, V2, NR121, NR122 & NR221 658 students
Time: 2 hours. Autumn Mid Semester Exam. 2015-2016 Full Marks: 120

**Instructions:** • Attempt **All** the questions. Intermediate calculation steps must be shown.
• Response to each question should start from the top of a fresh page.
• Parts of a particular question should be answered together at one place.

1. (a) For given three resistances $R_A$, $R_B$ and $R_C$ connected in delta, find the expressions for equivalent star resistances. [8]

   (b) For the circuit shown in Figure 1, calculate the range of values of $R$ such that the current from the battery can be adjusted from 50 mA to 100 mA. [12]

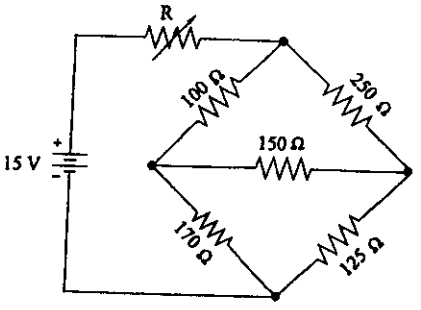


Figure 1: Pertaining to Q1(b)

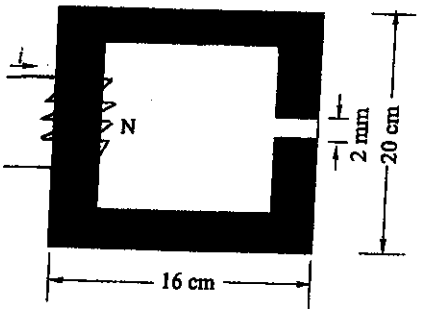


Figure 2: Pertaining to Q2(a)

2. (a) For a rectangular magnetic core with an air gap shown in Figure 2, $N = 500$ turns; the cross section of the core is 4 cm × 4 cm; and $\mu_r$ (iron core) = 5000. Assuming uniform flux density, find the excitation current $i$ needed to establish a flux density of 1.2 T in the air gap without considering the effect of fringing. [8]

   (b) Two identical 2500 turn coils A and B are in parallel planes such that 80% of the magnetic flux produced by one coil links the other. A current of 10 A in coil A produces a flux of 0.06 mWb in it. If the current in coil A changes from +10 A to -10 A in 0.02 s., what will be the magnitude of the voltage induced in the coil B? Calculate the self inductance of each coil and the mutual inductance. [4 + 4 + 4]

3. A single phase, 100V (rms), 50Hz source supplies a single phase load having impedance of 10 Ω and power factor of 0.8 (lag) through a line of impedance $\bar{Z}_{\text{line}} = (2+j6)\,\Omega$, as shown in Figure 3. A pure capacitor is connected in parallel (shunt) with the load. Two voltmeters, V1 and V2, are connected at the source and load terminals respectively as shown in the figure. Find the *minimum value* of the capacitance $C_{sh}$, such that the readings of the two voltmeters are exactly same. Find the load current $\bar{I}_L$ and the source current $\bar{I}_S$ under this condition? [10 + 5 + 5]

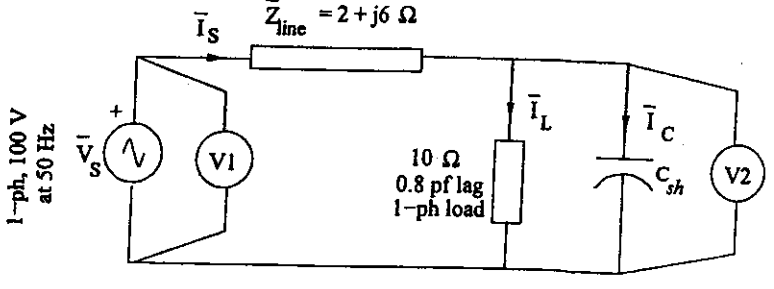


Figure 3: Pertaining to Q3.

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4. In the circuit shown in Figure 4, the switch is initially connected to point A for a long time such that the circuit reached steady state. At $t = 0$, the switch S, is moved very quickly to point B. Find $v_c(0^+)$ and $v_c(t)$ at $t = 0.08$ s. Obtain expression for $i_R(t)$ for $t \geq 0$ and sketch it. [3+10+3+4]

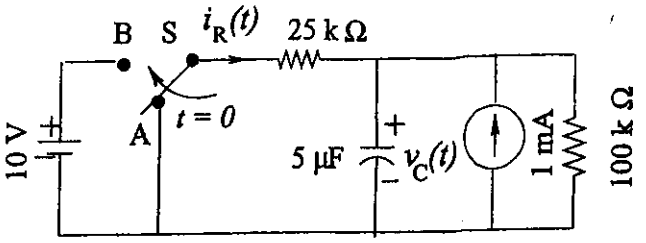


Figure 4: Pertaining to Q4

5. A wattmeter is connected in the balanced three phase resistive network as shown in Figure 5. Find the reading of the wattmeter. Assume $\bar{V}_{RY} = 100\angle 0°$ V and show $\bar{I}_R$, $\bar{I}_Y$ & $\bar{I}_B$ in a neatly drawn phasor diagram. [10 + 10]

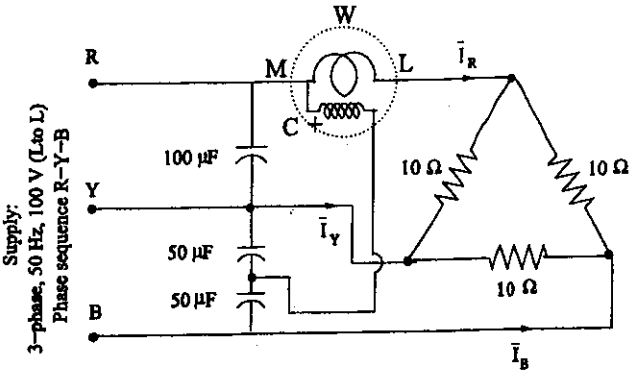


Figure 5: Pertaining to Q5

6. (a) Calculate the direction and magnitude of the current through the 5 Ω resistor between the points A and B in the circuit shown in Figure 6 by using nodal analysis method. [10]

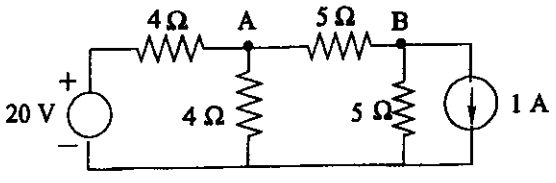


Figure 6: Pertaining to Q6(a)

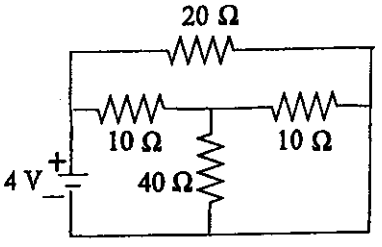


Figure 7: Pertaining to Q6(b)

(b) Calculate the current through the 40 Ω resistance in the network shown in Figure 7. [10]

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