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EE111 Introduction to Electrical Systems
Assignment 04

Instructions:

1. This is an individual assignment.
2. Show all of your work.
3. **Reading:** Chapters 10 and 11 of Course Text
4. **Due Date:** 28/09/2018

- **Question 1:** The following sets of values for v and i pertain to the circuit seen in Fig.1. For each set of values, calculate P and Q and state whether the circuit inside the box is absorbing or delivering (a) average power and (b) magnetizing VARs.

  1. v = 340 cos(ωt + 60°) V, i = 20 cos(ωt + 15°) A
  2. v = 75 cos(ωt - 15°) V, i = 16 cos(ωt + 60°) A
  3. v = 625 cos(ωt + 40°) V, i = 4 sin(ωt + 240°) A
  4. v = 180 sin(ωt + 220°) V, i = 10 cos(ωt + 20°) A

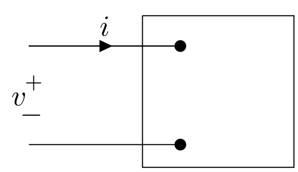

Fig.1

- **Question 2:** The load impedance Z_L in Fig.2 absorbs 40 kW and 30 magnetizing kVAR. The sinusoidal voltage source develops 50 kW.

  1. Find the values of capacitive reactance that satisfies these constraints.
  2. For each of these values, show that the magnetizing VAR developed equals the magnetizing VAR absorbed.

- **Question 3:**

  1. Find the rms value of the periodic voltage shown in Fig.3.

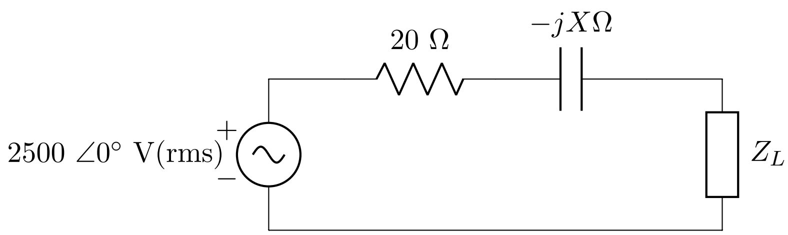

Fig.2

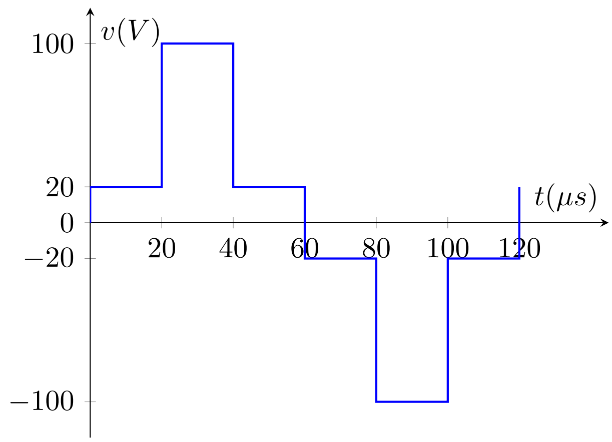

Fig.3

2. If this voltage is applied to the terminals of 12 Ω resistor, what is the average power dissipated in the resistor?

- **Question 4:** Three loads are connected in parallel across a 2400 V (rms) line as shown in Fig.4. Load 1 absorbs 18 kW and 24 kVAR; Load 2 absorbs 60 kVA at 0.6 pf lead. Load 3 absorbs 18 kW at unity power factor.

  1. Find the equivalent load impedance.
  2. Find the power factor of the equivalent load as seen from the line's input terminals.

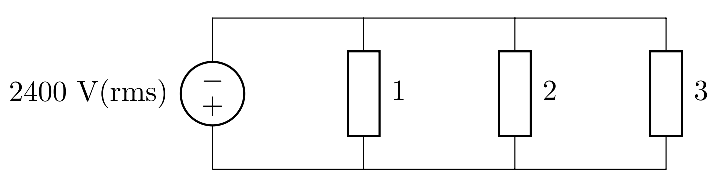

Fig.4

- **Question 5:**

  1. Determine the load impedance of the circuit shown in Fig.5 that results in maximum average power being transferred to the load if $\omega = 10$ krad/s.

2. Determine the maximum average power delivered to the load from part (1) if v_g = 90 cos(10000t) V.

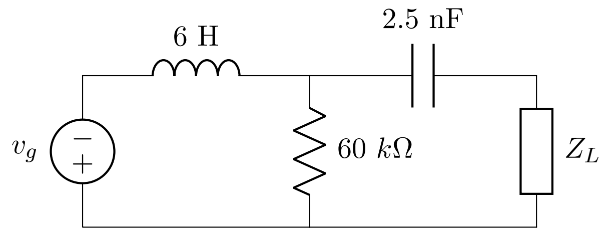

Fig.5

- **Question 6:** The impedance Z_L in Fig.6 is adjusted for maximum average power transfer to Z_L. The internal impedance of the sinusoidal voltage source is 8+j56 Ω.
  1. What is the maximum average power delivered to Z_L?
  2. What percentage of the average power delivered to the linear transformer is delivered to Z_L?

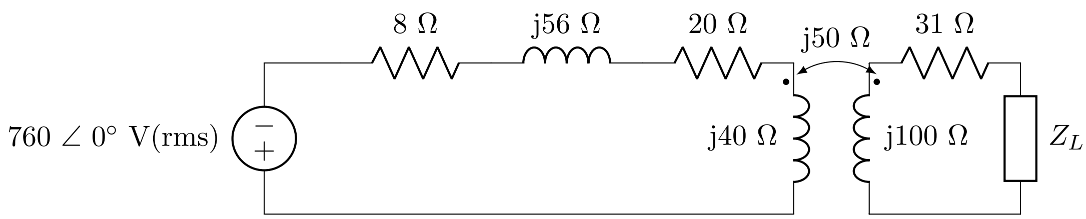

Fig.6

- **Question 7:** For each set of voltages, state whether or not the voltages form a balanced three phase set. If the set is balanced, state whether the phase sequence is positive or negative. If the set is not balanced, explain why.
  1. v_a = 339 cos(377t)V, v_b = 339 cos(377t - 120°)V, v_c = 339 cos(377t + 120°)V
  2. v_a = 622 sin(377t)V, v_b = 622 sin(377t - 240°)V, v_c = 622 sin(377t + 240°)V
  3. v_a = 933 sin(377t)V, v_b = 933 sin(377t + 240°)V, v_c = 933 cos(377t + 30°)V
  4. v_a = 170 sin(ωt + 60°)V, v_b = 170 sin(ωt + 180°)V, v_c = 170 cos(ωt - 150°)V
  5. v_a = 339 cos(ωt + 30°)V, v_b = 339 cos(ωt - 90°)V, v_c = 393 cos(ωt + 240°)V
  6. v_a = 3394 sin(ωt + 70°)V, v_b = 3394 cos(ωt - 140°)V, v_c = 3394 cos(ωt + 180°)V
- **Question 8:**
  1. Is the circuit in Fig.7 a balanced or unbalanced three phase system? Explain.
  2. Find I_0.
- **Question 9:** A balanced three phase circuit has following characteristics:

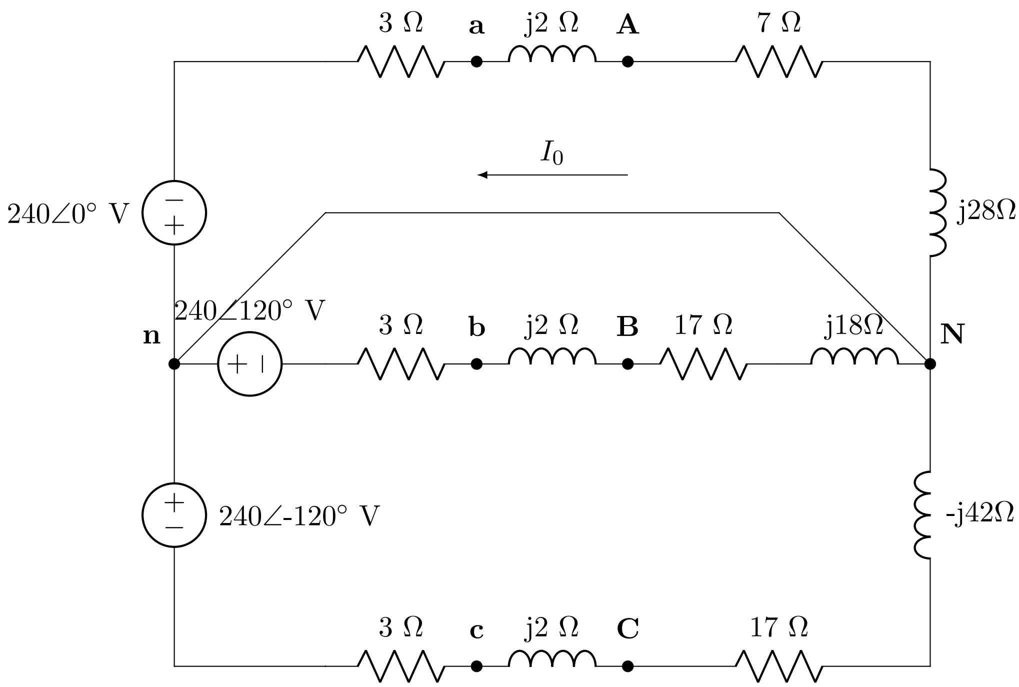

Fig.7

- Y-Y connected;
- The line voltage at the source, V_{ab}, is $120\sqrt{3}\angle\ 0°$ V;
- The phase sequence is positive;
- The line impedance is 2 + j3 Ω per phase;
- The load impedance is 28 + j37 Ω per phase.

1. Draw the single phase equivalent circuit for the a-phase.
2. Calculate the line current in a-phase.
3. Calculate the line voltage at the load in the a-phase.

- **Question 10:** A balanced Y-connected load having an impedance of 96 - j28 Ω per phase is connected parallel to an delta connected load having an impedance of 144 + j42 Ω per phase. The paralled loads are fed from a line having an impedance of j1.5 Ω per phase. The magnitude of the line to neutral voltage of the Y-load is 7500 V.

  1. Calculate the magnitude of the current in the line feeding the loads.
  2. Calculate the magnitude of the phase current in delta connected load.
  3. Calculate the magnitude of phase current in Y-connected load.
  4. Calculate the magnitude of the line voltage at the sending end of the line.

- **Question 11:** A 7200 $\sqrt{3}$ V delta connected source having internal impedance of 5.4 + j27 Ω as shown in Fig.8 is connected to a Y-connected load by means of a balanced three phase distribution line. The load impedance is 957 + j259 Ω per phase and the line impedance is 1.2 + j12 Ω per phase.

1. Construct a single phase equivalent circuit of the system.
2. Determine the magnitude of the line voltage at the load terminals.
3. Determine the magnitude of the phase current in the Δ source.
4. Determine the magnitude of the line voltage at the source terminals.

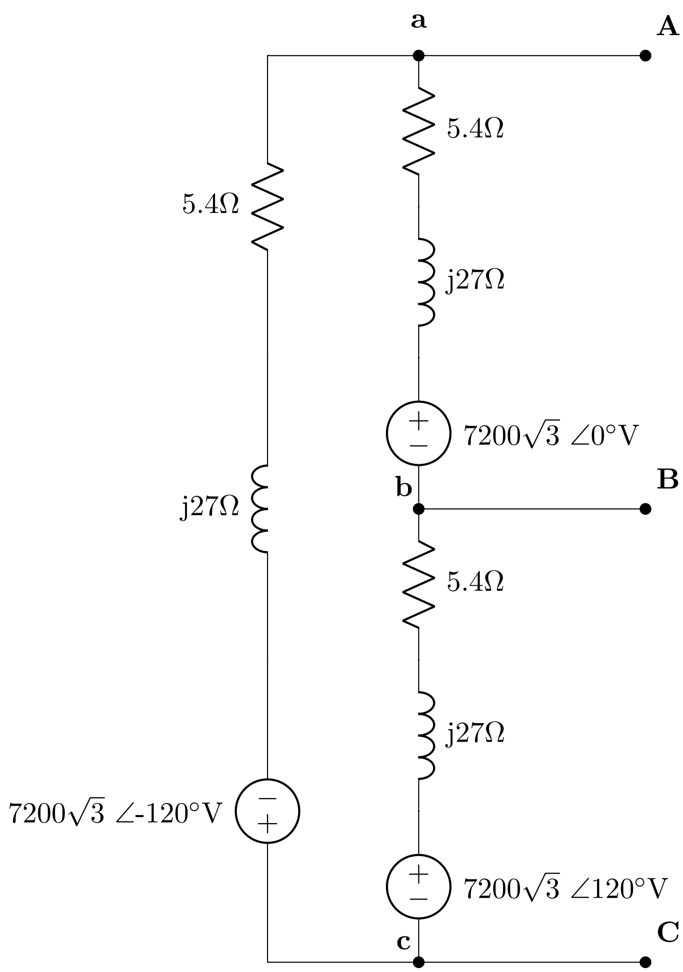

Fig.8

- **Question 12:** A three phase positive sequence Y-connected source supplies 14 kVA with a power factor of 0.75 lagging to a parallel combination of Y-connected load and Δ-connected load. The Y-connected load uses 9 kVA at a power factor of 0.6 lagging and has an a-phase current of $10\angle\text{-}30°$ A.

    1. Find the complex power per phase of Δ-connected load.
    2. Find the magnitude of the line voltage.