E927500
Circuit Analysis
April 13, 2016

Mid Term I

A. (5×9=45 points) Explain or answer each of the following statements.

1. Comparison between "steady-state response" and "transient response", and also comparison between "homogeneous solution" and "particular solution".
2. Comparison among "Phasor", "Fourier transform", and "Laplace transform".
3. Describe "superposition" based on linearity and give an example in circuit. Hint: Phasor analysis applies only when frequency is constant; when it is applied to two or more sinusoid signals only if they have the same frequency.
4. $\frac{dv}{dt}$ (time domain) $\Leftrightarrow j\omega\mathbf{V}$ (phasor domain) by Laplace transform first, and then Fourier transform.
5. An inductor acts like an open circuit at high frequencies and a capacitor can reject a dc signal. ***Constraint:*** you must use the impedance concept in the phasor domain.
6. In Fig. 1, the output is taken across the resistor. Does the output voltage $v_o(t)$ across the resistor lead the input voltage $v_i(t)$? Please derive the phase according to the R and C.
7. Comparison between "open-loop gain" and "closed-loop gain" in op amp circuit, and also comparison between "negative feedback" and "positive feedback".
8. The oscillator is a circuit produces an ac waveform as output when powered by dc input. Explain $f_o = 1/2\pi RC$ in Fig. 2.
9. Maximum average power is transferred to a purely real load when the load resistance is the norm of the Norton equivalent impedance as seen from the load terminals, i.e. $R_L = |\mathbf{Z}_N|$.

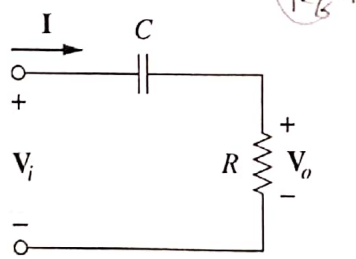

Fig. 1

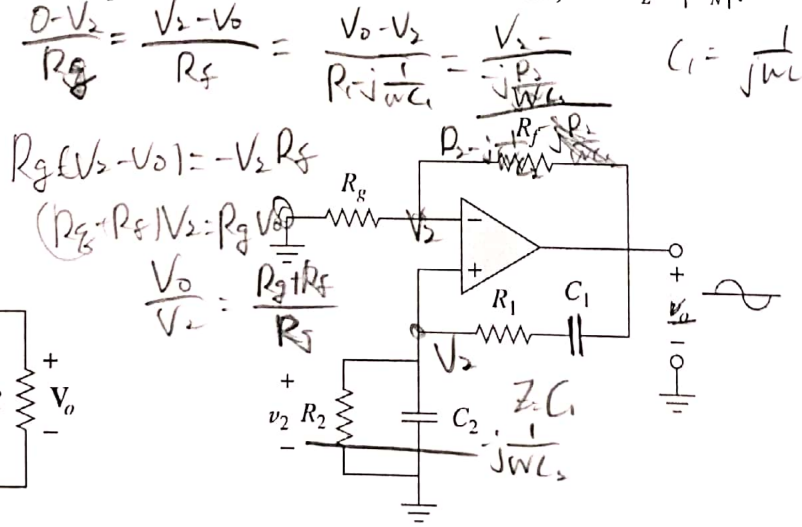

Fig. 2

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B. (10+5=15 points) Op Amp AC Circuits:

(a) Determine $v_o(t)$ in the op amp circuit in Fig. 3. (b) No inductor can be found in this op am circuit. *Why?*

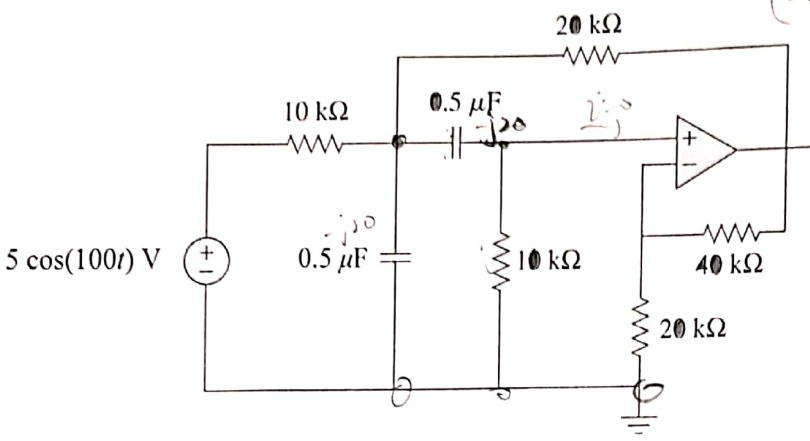

Fig. 3

C. (12+5+5=22 points) Maximum Average Power Transfer:

(a) Determine the Norton equivalent of the circuit in Fig. 4 as seen from terminals *a*-*b*. (b) If a loading is added between terminals *a* and *b*, please find a matching impedance that absorbs the maximum average power and calculate P_{max}. (c) Find the average power of each source.

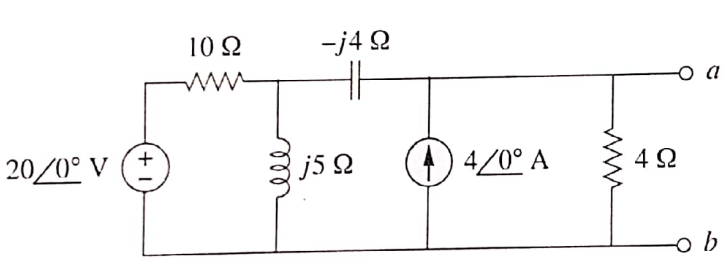

Fig. 4

D. (5+5+8+10=28 points) Power Factor Correction:

(a) To mitigate the inductive aspect of the load, a capacitor is added in parallel with the load. *Why not in series?* (b) The power factor has improved. With the same supplied voltage, the current draw is less by adding the capacitor. *Why?* (c) Derive $Q_c = V_{rms}^2 / X_c = \omega C V_{rms}^2$. (d) Find the value of parallel capacitance needed to correct a load of 150 kVAR at 0.8 lagging pf to 0.95 lagging pf. Assume that the load is supplied by a 110 V (rms) @ 60 Hz line.

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