Electric Circuits 2 - Final Exam

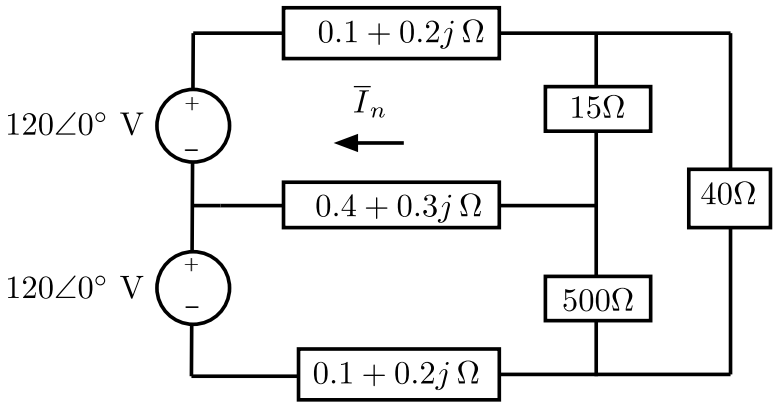
Note: This is a take home examination. You are free to use MATLAB or Python. The exam is open book/notes. Your submission is due by 10pm of the day it was e-mailed to you. Contact me by e-mail if you have any questions on the exam and I will get back to you as soon as humanly possible.

The exam consists of 8 *multiple choice questions* and 2 *written problems*. For the *written problems* it is suggested that you show your work since this is the basis for partial credit. Showing your work for the *multiple choice questions* may also be useful if you are unable to identify the correct solution or your chosen solution is incorrect.

In accordance with the academic code of conduct, your dated signature below certifies that your answers were obtained without collaboration or consultation with others.

SIGNATURE _____ DATE _____

Multiple Choice Question 1: What is the current phasor, $\overline{I}_n$ in the AC circuit whose impedance diagram is shown below?



[A] $19.94\angle -1.48°$ A

[B] $13.65\angle -1.75°$ A

[C] $7.96\angle -1.85°$ A

[D] $7.46\angle -87.53°$ A

[E] $7.46\angle -2.47°$ A

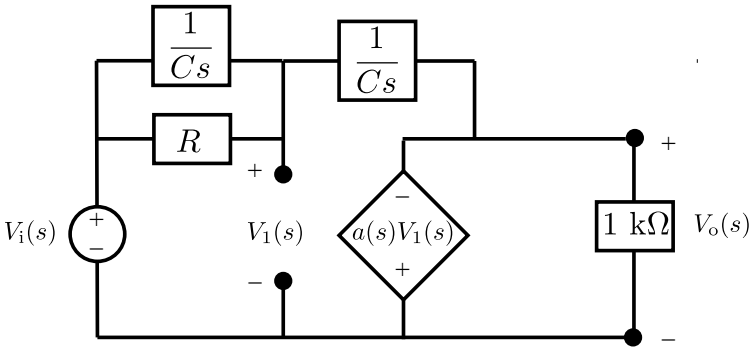
Multiple Choice Question 2: Consider the time-domain signal,

$$v(t) = (2 - e^{-at} - e^{-bt})u(t)$$

where a and b are positive parameters. Determine the zeros of the signal's single sided Laplace transform.

[A] two zeros at -ab **[B]** $-\dfrac{a+b}{ab}$ **[C]** $-\dfrac{ab}{a+b}$ **[D]** $\pm(\sqrt{ab})j$ **[E]** $-\dfrac{2ab}{a+b}$

Multiple Choice Question 3: Consider the circuit shown below where $a(s) = \frac{10^4}{s+100}$, $R = 10^3$ ohms, and $C = 100$ μF. Determine the transfer function from $V_i(s)$ to $V_o(s)$.



$$R = 1000\ \Omega \qquad C = 100\ \mu\text{F} \qquad a(s) = \frac{10^4}{s+100}$$

[A] $\dfrac{5000s}{(s+5095)(s+9.912)}$

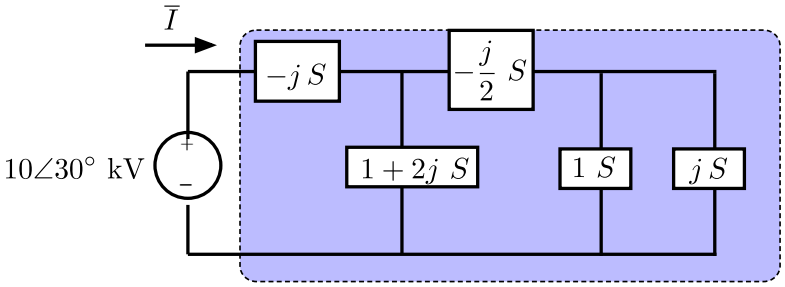
[B] $-\dfrac{(s+100)(s+10)}{(s+2\times10^4)(s+4.976)}$

[C] $\dfrac{-5000(s+10)}{(s+5105)(s+0.098)}$

[D] $-\dfrac{500}{(s+604.2)(s+0.8276)}$

[E] $\dfrac{5000(s+10)}{(s+5105)(s+0.098)}$

Multiple Choice Question 4: Consider the AC circuit whose *admittance diagram* is shown below. Determine the real and reactive power absorbed/delivered by the circuit in the shaded box.



[A] 75 MW, -125 Mvar

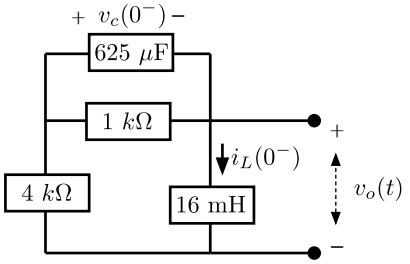
[B] 12.74 kW, -7.07 kvar

[C] 145.75 MW, 2.45 Mvar

[D] 42.31 MW, -88.46 Mvar

[E] 75 MW, 125 Mvar

Multiple Choice Question 5: Consider the circuit shown below where $i_L(0^-) = 0$ A. Determine the single sided Laplace transform for the time domain signal $v_o(t)$ as a function of the initial capacitor voltage $v_c(0^-)$.



[A] $-\dfrac{s}{(s+2.5\times10^5)(s+2)}$

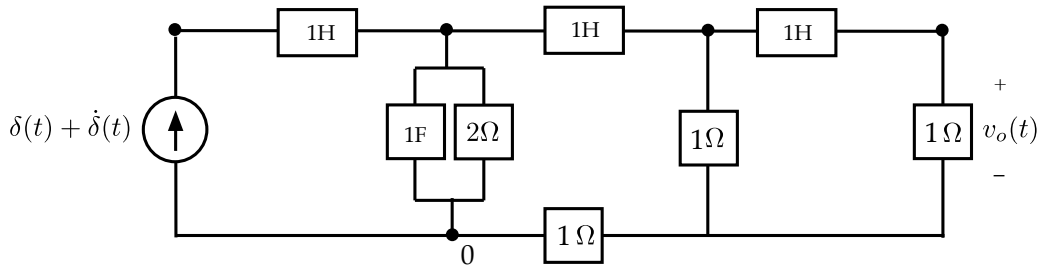
[B] $-\dfrac{v_c(0^-)(s+1.6)}{(s+2.5\times10^5)(s+2)}$

[C] $\dfrac{v_c(0^-)s}{(s+2.5\times10^5)(s+2)}$

[D] $-\dfrac{v_c(0^-)s}{(s+2.5\times10^5)(s+2)}$

[E] $-\dfrac{v_c(0^-)s}{(s+2.5\times10^4)(s+2)}$

Multiple Choice Question 6: Consider the circuit shown below. Assume there is no energy stored in in its inductors and capacitors just before time $t = 0$. Determine the single sided Laplace transform of the voltage waveform $v_o(t)$.



[A] $\dfrac{s+1}{(s+2.806)(s^2+1.694s+1.247)}$ **[B]** $\dfrac{1}{(s+2.806)(s^2+1.694s+1.247)}$ **[C]** $\dfrac{1}{(s+3)(s+0.5)}$

[D] $\dfrac{s(s+1)}{(s+4.2)(s+1.46)(s+0.5)(s+0.32)}$ **[E]** $\dfrac{s+1}{s(s+2.806)(s^2+1.694s+1.247)}$

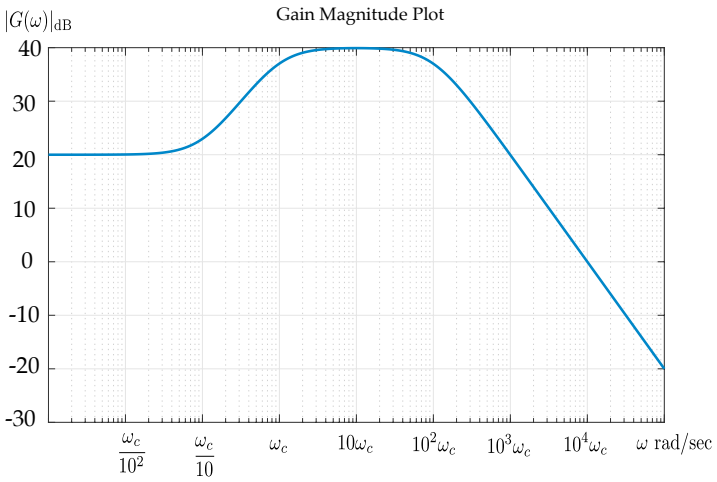
Multiple Choice Question 7: Consider the following Laplace transform

$$V(s) = \frac{Ks}{s^2 + 2Ks + 100} = \frac{R}{s - p} + \frac{R^*}{s - p^*}$$

where R is the residue for the pole p and K is a parameter. What is the modulus of the residue, $|R|$, assuming that $0 < K < 10$?

[A] $\dfrac{10K}{\sqrt{100 - K^2}}$ **[B]** $\dfrac{5K}{\sqrt{100 - K^2}}$ **[C]** $\dfrac{5K}{\sqrt{100 + K^2}}$ **[D]** $\dfrac{5}{\sqrt{100 - K^2}}$

Multiple Choice Question 8: Determine the transfer function that could have generated the following Bode plot.



[A] $10\dfrac{s+\omega_c/10}{(s+\omega_c)(s+100\omega_c)}$

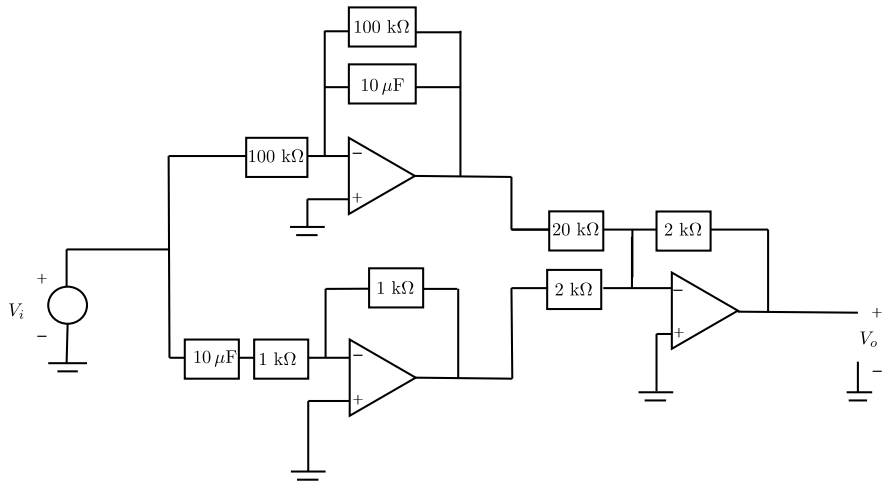
[B] $10^4\omega_c\dfrac{s+\omega_c/10}{(s+\omega_c)(s+100\omega_c)}$

[C] $10\omega_c^3\dfrac{1}{(s+\omega_c/10)(s+\omega_c)(s+100\omega_c)}$

[D] $10\omega_c\dfrac{s+\omega_c}{(s+\omega_c/10)(s+100\omega_c)}$

[E] $100\omega_c\dfrac{s+\omega_c/10}{(s+\omega_c)(s+10\omega_c)}$

Written Problem 1: Consider the active filter shown below. Determine the filter's transfer function, identify the type of filter (i.e. high pass, low pass, etc.) and identify the filter's passband (i.e. those frequencies, ω, where $|G(j\omega)| > \frac{1}{\sqrt{2}}|G(j\omega_{\max})|$ with $\omega_{\max}$ being the frequency where $|G|$ is greatest.)



Written Problem 2: Consider the switched circuit shown below whose switch has been in position a for a long time before moving instantly to position b at $t = 0$. Determine the time-domain voltage, $v_2(t)$, for $t \geq 0$.