Columbia University
Department of Electrical Engineering
Midterm Examination II
EE 3201. Fall, 1996
November 27, 1996
Time: 75 minutes
Total: 100 points

NAME ___________________________________________

Read carefully before you proceed:

1. This exam is closed book, closed notes.

2. Put all answers in the space provided in the exam booklet.

3. Partial credit will be given. If you don’t have time to work a problem completely, explain how you would solve it and try to set up the problem. No credit will be given for answers without explanation.
1. Please work the following short problems or questions. You should be able to answer these without a lot of calculations!

(a) Write $(4 + j5)(3 - j8)$ in polar form and sketch it as a vector in the complex plane. (6 points)

(b) What is $v_{\text{out}}$ in the following circuit at $\omega = \frac{1}{\sqrt{LC}}$? Please explain your answer. (6 points)
(c) What is the input impedance of the following circuit at $\omega = 20 \text{rad/sec}$?
(6 points)
(d) Consider a transfer function \( H(s) = \frac{V_{\text{out}}(s)}{V_{\text{in}}(s)} \) given by pole-zero configuration shown below. \( \times \) denotes a pole while \( \circ \) denotes a zero. If \( H(0) = 1 \) (i.e., the gain at DC is unity), write an explicit function for \( H(s) \) in terms of the ratio of two polynomials in \( s \). (6 points)
(e) Consider the circuit shown below. At what value of C will $v_2(t)$ have maximum amplitude? What will $v_2(t)$ be at this value of C? (6 points)
2. Find $v_o(t)$ in the following circuit. (15 points)
3. Consider the following circuit. Find the source voltage $V_s$ (rms value and power factor) required to deliver 50 kW at 220 V rms at 60 Hz at the load with a power factor of 0.8 lagging. (20 points)
4. The network shown below is one of the simplest active networks that realizes a second-order low-pass filter. Assume that the OP AMP is ideal and ignore OP AMP saturation.

(a) At DC, what is the gain of the network, $V_2/V_1$? (5 points)
(b) Show that the transfer function $H(s) = V_2/V_1$ is given by the form

$$H(s) = \frac{-a_o}{s^2 + \frac{s \omega_c}{Q} + \omega_c^2}$$

and find (positive) numerical values for $a_o$, $Q$, and $\omega_o$. (20 points)
(c) Plot the Bode magnitude and phase plot for the transfer function you calculated in (b). What is the break frequency? What is $|H(j\omega)|$ at the break frequency? If you were unable to compute the values of $a_0$, $Q$, and $\omega_0$ in part (b), give your answers in terms of these parameters. (10 points)