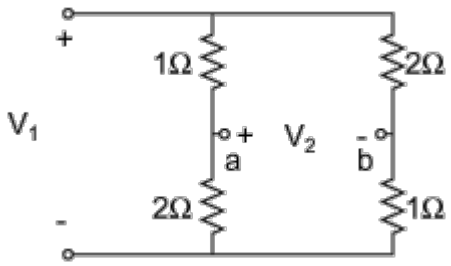
MASSACHUSETTS INSTITUTE OF TECHNOLOGY

DEPARTMENT OF ELECTRICAL ENGINEERING AND COMPUTER SCIENCE

6.002 Circuits and Electronics Final Exam Practice Set 2

Problem 1

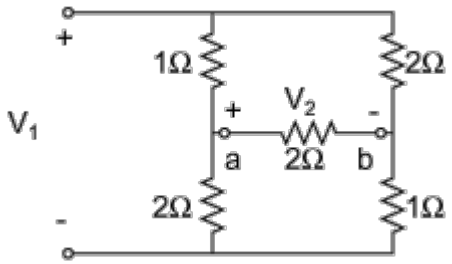
(a)



In the circuit above, if V_1= 10 V what is V_2?

Answer: V_2= _____

Problem 1 (cont'd)
(b)

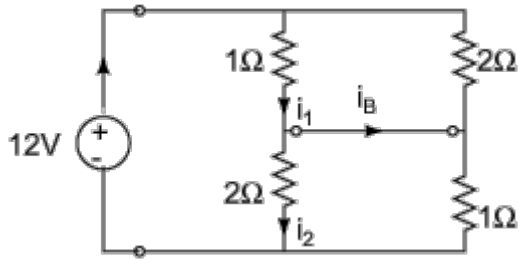


A resistor of value 2 Ω is now connected between the terminals a – b as shown above. What is V_2 if V_1 = 10 V?

Answer: V_2= _____

Problem 1 (cont'd)

(c)

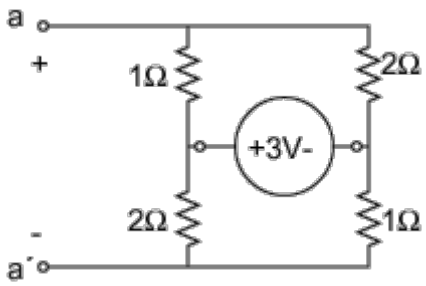


The 2 Ω bridging resistor is now replaced by a short circuit as shown above. Determine the current i_B.

Answer: i_B = _____

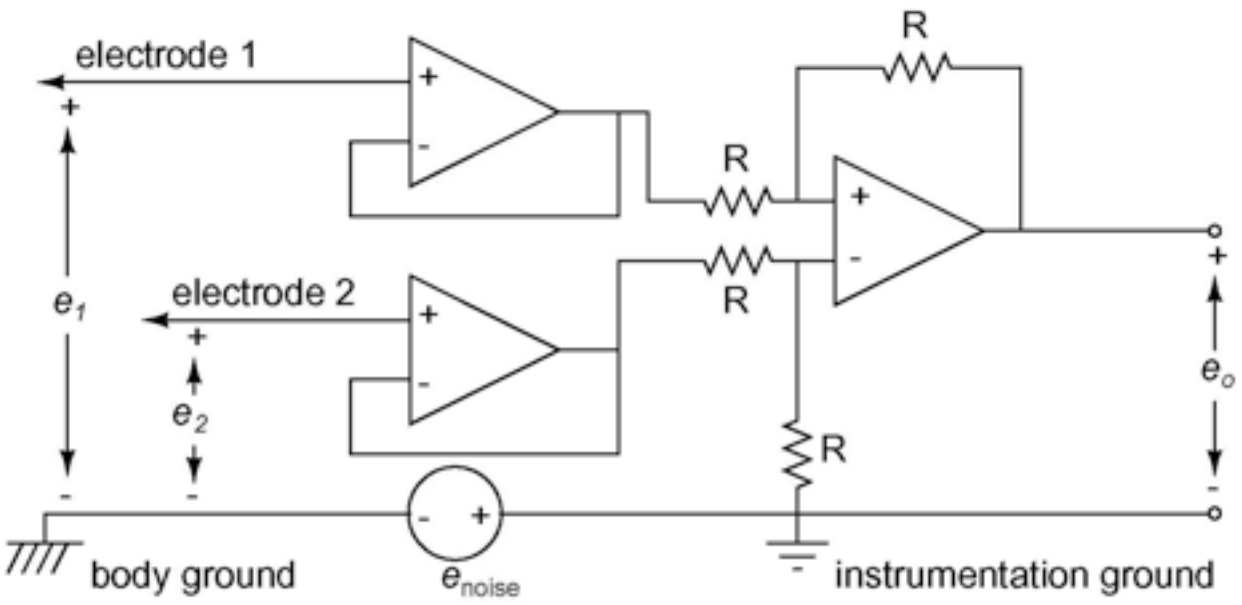
Problem 1 (cont'd)

(d)



The short circuit is now replaced by a voltage source of value 3 V. Determine and draw the Thevenin equivalent circuit seen from terminals a – a'. Be sure to indicate values of the elements.

Problem 3



An electrocardiogram (EKG) machine produces a recording of the neuro-electrical stimulation of the heart. Electrodes are attached to the body in various places and the potentials among them measured. A challenge with this measurement is that the potential reference of your body is different from that of the instrumentation, and noise is invariably present between these two references. The circuit above is being used to measure the potential difference between electrodes 1 and 2, i.e., $e_o = f(e_1 - e_2)$. The source e_{noise} models the undesirable noise introduced between the two ground references – the arrow representing instrumentation ground and the comb representing earth or body ground. Determine the output voltage $e_o = f(e_1 - e_2)$. Assume that the op-amps are ideal.

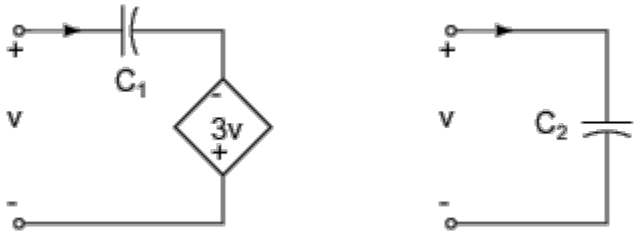
Problem 3 (cont'd)

Answer: e_o =

Problem 4

Two circuits are *terminal equivalents* if and only if they have identical behavior, as determined in terms of voltages between terminals and currents into terminals. For each pair of circuits shown below, the circuits are terminal equivalent when the unspecified circuit parameters satisfy some relations. For each pair you are to determine the constraints on the parameters that make the circuits terminal equivalent.

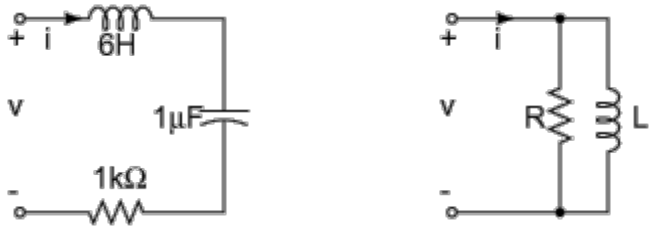
(a) For the circuits below, specify the relationship between C_1 and C_2 that makes them terminal equivalents. (Note that the diamond symbol represents a dependent source, in this case a voltage source dependent on the terminal voltage.)



Answer: C_2 =

Problem 4 (cont'd)

(b) Specify the values of L and C that make the circuits below terminal equivalents for sinusoidal excitations at the angular frequency of 500 radians/second.

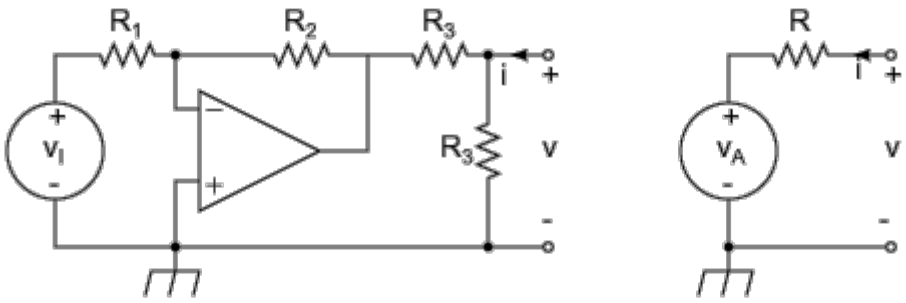


Answer: R = _____

L = _____

Problem 4 (cont'd)

(c) For the circuits below, determine the values of v_A and R in terms of v_I, R_1, R_2 and R_3 that make these circuits terminal equivalents. Assume that the op-amp is ideal.



Answer: V_a =

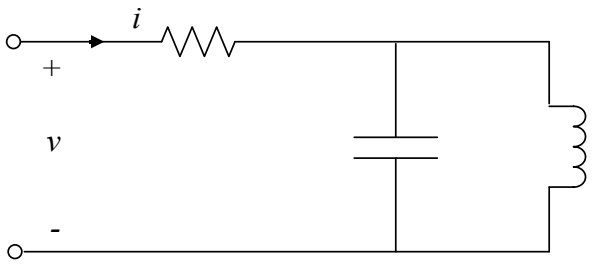
R =

Problem 5

Each of the six circuits shown below has a separate system function $H(jw)$ defined for it. Match the system function to one of the eight characteristic plots shown on last page of the exam. Enter the number of the matching plot in the space provided to the right of the circuit. Some system functions correspond to more than one plot, i.e., both a phase and a magnitude. You need choose only one match. If more than one match is chosen, both must be correct. Note that some plots have linear scales and some have log scales. Credit will only be given for a correct match. (This problem does not require extensive calculations, and may be done by inspection).

(a)

Circuit



Matching Plot

( )

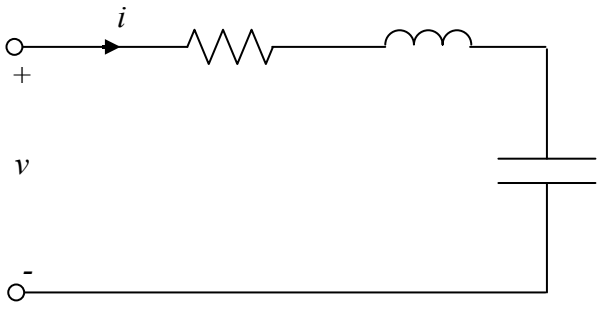
System Function

$$H(jw) = \frac{I(jw)}{V(jw)}$$

Problem 5 (cont'd)

(b)

Circuit



Matching Plot

( )

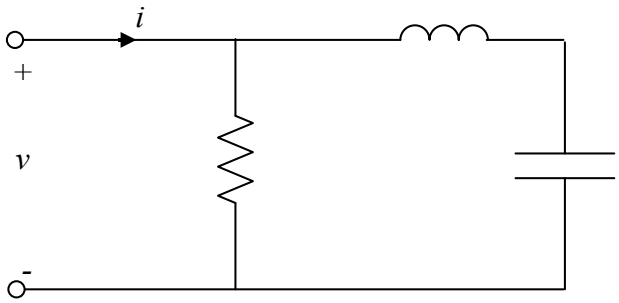
System Function

$$H(jW) = \frac{V(jW)}{I(jW)}$$

Problem 5 (cont'd)

(c)

Circuit



Matching Plot

( )

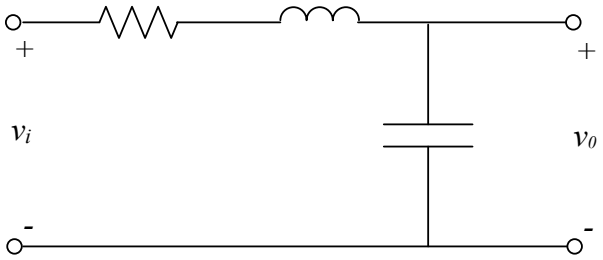
System Function

$$H(jw) = \frac{V(jw)}{I(jw)}$$

Problem 5 (cont'd)

(d)

Circuit



Matching Plot

( )

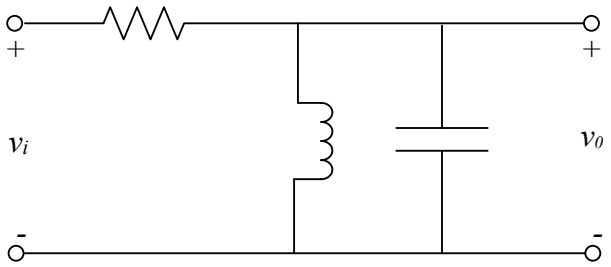
System Function

$$H(jw) = \frac{V_o(jw)}{V_i(jw)}$$

Problem 5 (cont'd)

(e)

Circuit



Matching Plot

( )

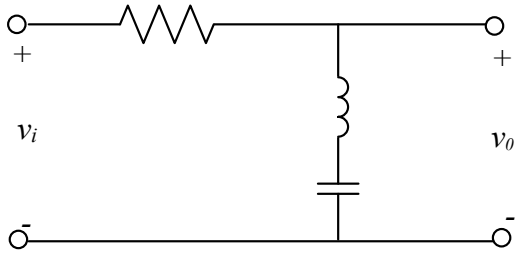
System Function

$$H(jw) = \frac{V_o(jw)}{V_i(jw)}$$

Problem 5 (cont'd)

(f)

Circuit



Matching Plot

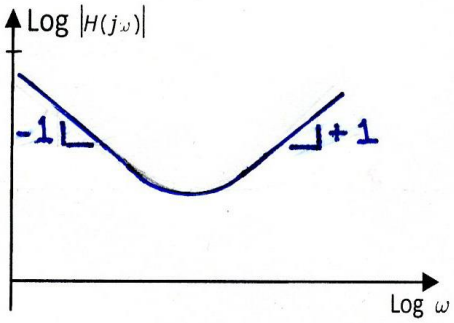
( )

System Function

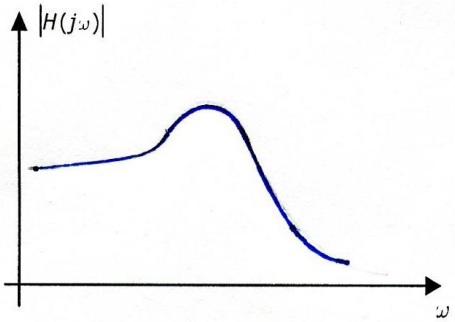
$$H(jw) = \frac{V_o(jw)}{V_i(jw)}$$

 Name:_____

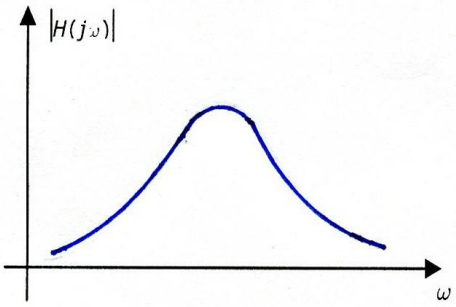
(1)



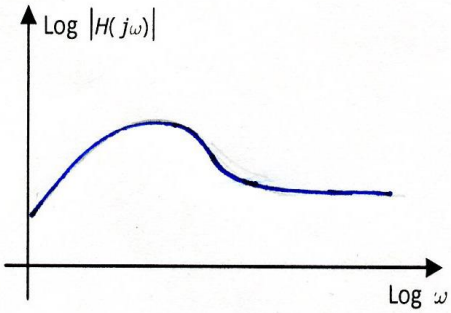
(2)



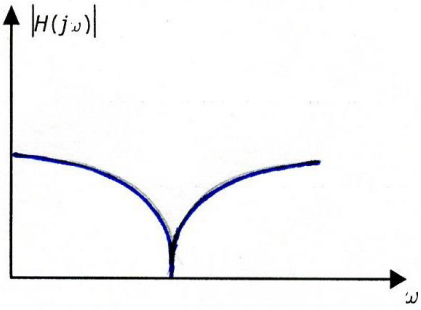
(3)



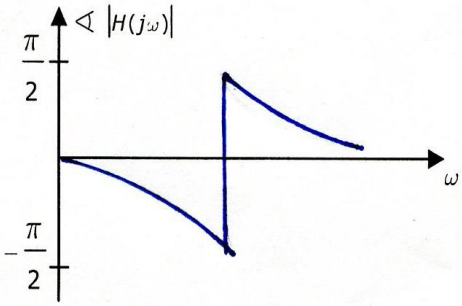
(4)



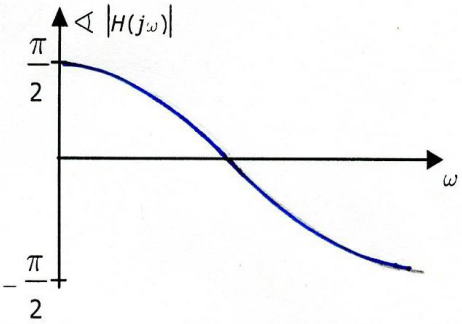
(5)



(6)



(7)



(8)