EE201 Circuit Theory
KAIST, Spring 2014

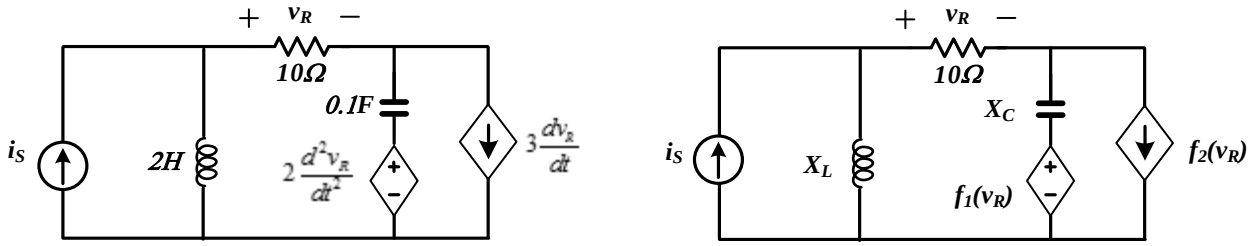
June 17, 2014

학번:_____ 이름:_____

Final Exam (2.5 hours)

1. Determine whether the following input, output pair is possible in a linear system. (ω>0) [5pts]
   (a) input = cos(ωt) , output = cos(ωt+θ) (True, False)
   (b) input = cos(ωt) , output = cos(2ωt) (True, False)
   (c) input = cos(ωt) , output = Acos(2ωt), where A is complex (True, False)
   (d) input = cos(ωt) , output = A_1cos(ωt) + A_2sin(ωt), where A_1,A_2 are real. (True, False)
   (e) input = δ(t) , output = exp(-t/τ) cos(ωt) u(t) (True, False)

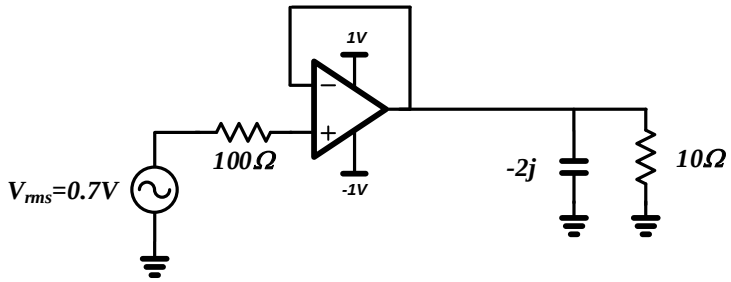
2. Represent the impedance of the below circuit in complex domain when input current (i_S) has frequency of ω. [10pts]



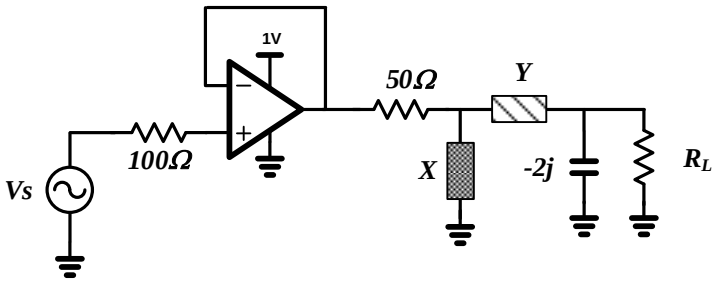
X_L= _____, X_C= _____, $f_1(v_R)$ = _____, $f_2(v_R)$ = _____

3. Consider the circuits shown below [12pts]

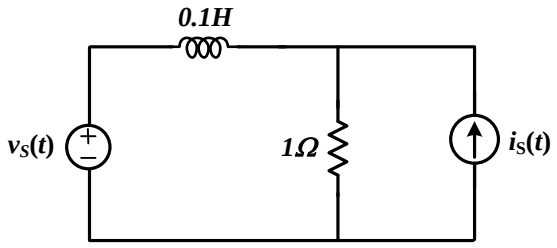
(a) Consider the circuit shown below, where the output of the opamp is limited by its supply voltage. Please modify the circuit by adding passive device(s) such that the power delivered to the output load (R_L) is 10W. Specify the value of parameters of the passive device(s) that you added. [6pts]



(b) Please determine the value of the device R_L, X and Y in the below circuit such that maximum power is delivered to the resistive load, R_L. [6pts]



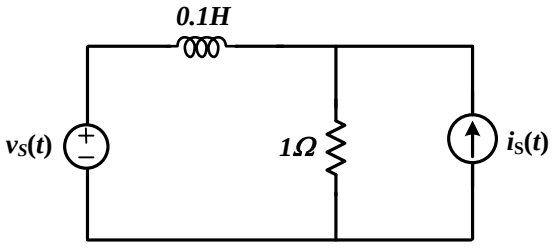
4. Consider the circuit shown below. [20pts]



(a) Suppose $v_S(t) = \cos(10t)$ and $i_S(t) = \sqrt{2}\cos(10t+45^O)$. Find the steady-state voltage across the resistor $v_R(t)$. Express your answer in time-domain. [4pts]

(b) What is the average power dissipated in the resistor R? [4pts]

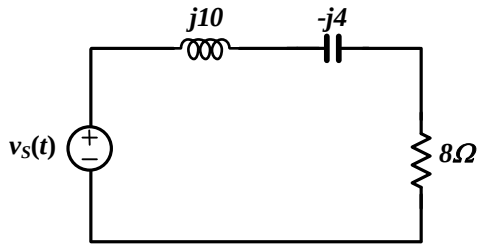
(c) Suppose $v_S(t) = \cos(10t)$ and $i_S(t) = \cos(20t)$. Find the steady-state voltage across the resistor $v_R(t)$. Express your answer in time-domain. [4pts]



(d) Suppose voltage across a resistor is $A_1\cos(\omega_0 t)+A_2\cos(n\omega_0 t)$. What is the average power over T_0, where $T_0=2\pi/\omega_0$? [4pts]

(e) Suppose $v_S(t) = u(t)$ and $i_S(t) = \cos(10^3 t + 60^O)$. Find the steady-state voltage across the resistor $v_R(t)$. Express your answer in time-domain. [4pts]

5. Consider the circuit shown below. [15pts]



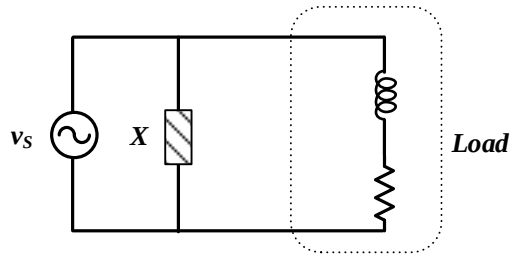
(a) Suppose the voltage source has a frequency of 60Hz. What is the power factor (PF)? [3pts]

(b) How does the PF change if frequency is increased from 60Hz to 120Hz? [2pts]

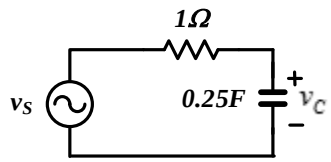
(i) PF increases (ii) PF decreases (iii) PF stays the same

(c) Suppose the input is a square wave of 60Hz. Will the PF increase or decrease compared to (a)? Explain why. [4pts]

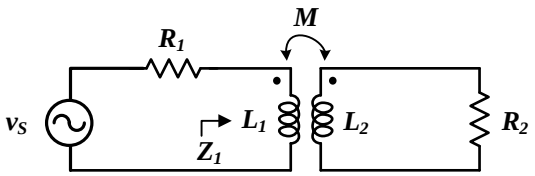
(d) The load in the below circuit consumes 100Watts at a lagging PF of 0.8. The source voltage is 100 V rms at 100 rad/s. In order to increase the PF to 1, a corrective device (X) is added. Determine the type and value of X. [6pts]



6. Find out $v_C(t)$ of the below circuit for $t>0$, when $v_S(t) = e^{-3t}u(t)$ [5pts]



7. [Mutual inductance] [10pts]



P_{SRC} is the power delivered from the source. $P_{R1,2}$ is the power dissipated in the resistors. k is the coupling coefficient. E_{SRC} is the energy delivered from the source. E_X is the energy stored or dissipated in device X.

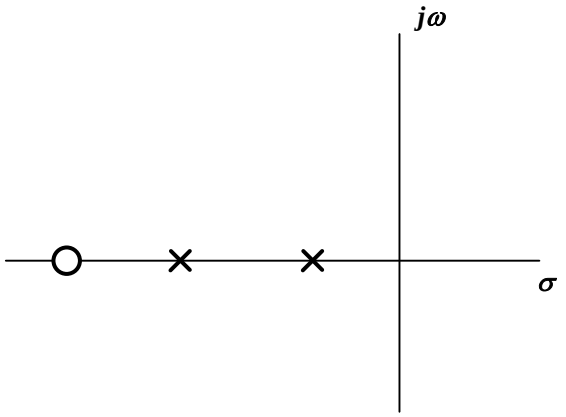
(a) Suppose $v_s(t) = u(t)$ and k=1. Is $P_{SRC} = P_{R1} + P_{R2}$ at any given time instant? (Yes, No)
If your answer is "No", then please describe where the missing power is. [3pts]

(b) Suppose $v_s(t) = u(t)$ and $k < 1$. Is $E_{SRC} = E_{R1} + E_{R2} + E_{L1} + E_{L2} + E_M$? (Yes, No)
If your answer is "No", then please describe where the energy is lost. [3pts]

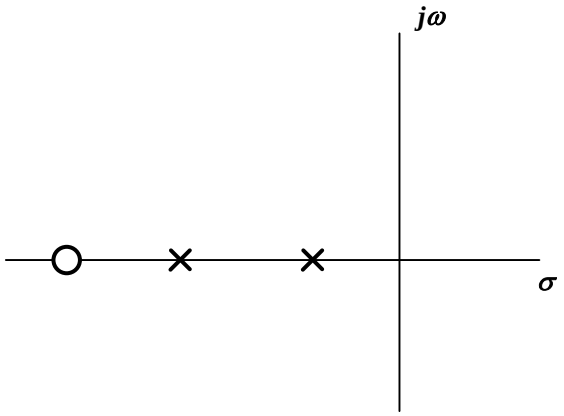
(c) Suppose k<1. What is the resistance (NOT impedance) seen from Z_1? Assume $L_1=L_2=L$, $R_1=R_2=R$, $\omega L >> R$. [4pts]

8. Please draw and explain the meaning of magnitude and phase of frequency response of a transfer function H(s) in a complex-domain plot. [8pts]

(a) In the below pole-zero plot, explain graphically what the magnitude of H(s) is at ω=100Hz. [4pts]

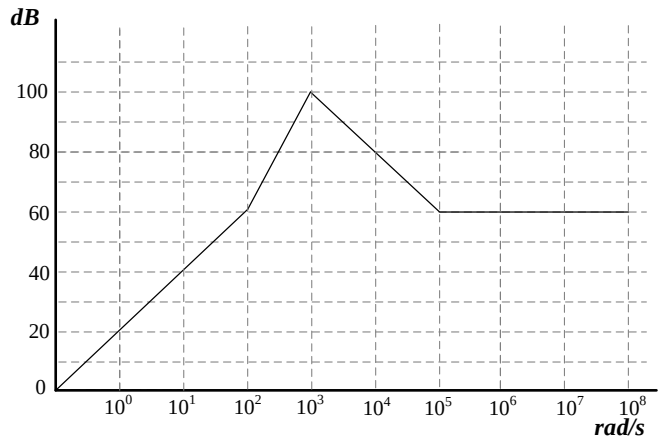


(b) In the below pole-zero plot, explain graphically what the phase of H(s) is at ω=100Hz. [4pts]



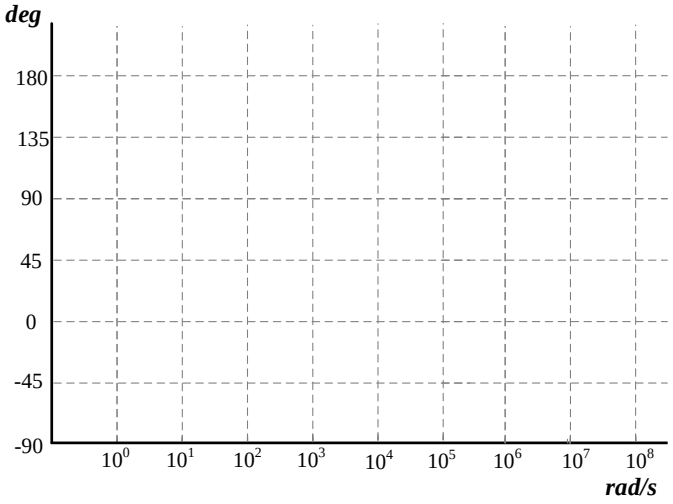
9. [Frequency response] [8pts]

(a) What transfer function H(s) results in the below frequency response of |H(s)|? [4pts]



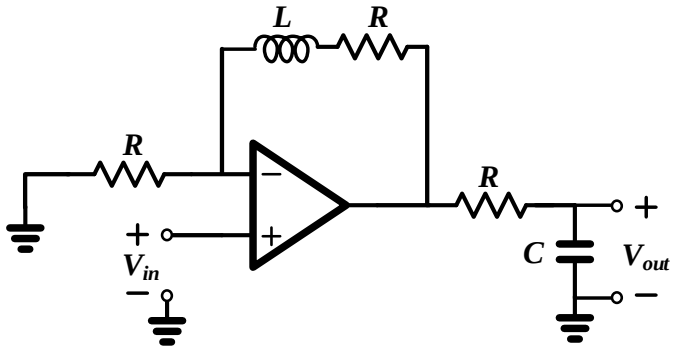
(b) Draw the phase plot of H(s). [4pts]

$$H(s) = \frac{s(s+10^2)}{(s+10^4)(s+10^6)}$$



10. Consider the circuit shown below.

(a) Find the transfer function $H_0(s)$, from V_{in} to V_{out}. [4pts]



(b) Suppose we want a new transfer function, $H_{new}(s) = H_0(s) \times \frac{1}{(sRC+1)}$. Please design a circuit that provides the above function. You will receive more points if you minimize the number of components used. [3pts]

학번(ID):_____ 이름(Name):_____

#1	#2	#3	#4	#5	#6	#7	#8	#8	Total
/8	/5	/12	/19	/8	/16	/15	/10	/7	/100