UNIVERSITY OF TORONTO
DEPARTMENT OF ELECTRICAL & COMPUTER ENGINEERING
FINAL EXAMINATION - DECEMBER 2001
Second Year - Programs 7,9
ECE212F - CIRCUIT THEORY
EXAMINERS - R. Iravani, L.A. de Windt and B. Wang

NAME (Please print):		
	Family Name	Given Name
STUDENT NUMBER:		

EXAMINATION TYPE: Type A; Papers for which no data are permitted other than the information printed on the examination paper.

CALCULATORS: Non-programmable scientific type permitted.

DURATION: 2.5 hours.

INSTRUCTIONS:

- **DO NOT UNSTAPLE THIS EXAM BOOK.**
- **Answer all six (6) questions.**
- Answer each question neatly and concisely. Write the final answer in the box provided.
- Answers to all questions must be supported by calculations.
- The back side of each adjacent page may also be used for your answer.
- One extra sheet can be found at the back of this booklet for the continuation of answers.

QUESTION	SHEET NUMBER	VALUE	MARKS
1	Page 2	20 marks	
2	Page 3	20 marks	
3	Page 4	20 marks	
4	Page 5	20 marks	
5	Page 6	20 marks	
6	Pages 7-8	20 marks	
TOTAL:		120	

Question 1 (20 marks)

For the circuit shown in Figure 1, determine:

(5 marks) i) the voltage gain v_0/v_s

(5 marks) ii) the current gain i_0/i_s

(5 marks) iii) the input resistance R_{in} seen by the voltage source v_s

(5 marks) iv) the power absorbed or supplied by the dependent voltage source when v_s=100mV

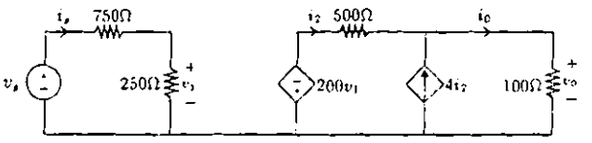


Figure 1

Answers:

i) v_0/v_s = _____

ii) i_0/i_s = _____

iii) R_{in} = _____

iv) P_{DV} = _____ _____

absorbed or supplied

Question 2 (20 marks)

For the circuit shown in Figure 2,

(10 marks) i) Find the Thevenin equivalent circuit with respect to terminals *a* and *b*.

(5 marks) ii) What is the maximum power absorbed by R_L?

(5 marks) iii) The circuit in Figure 2 has been analyzed, and it is reported that the current through R_L is 4mA. Is this value correct? If so, what is the value of R_L? If not, justify your answer.

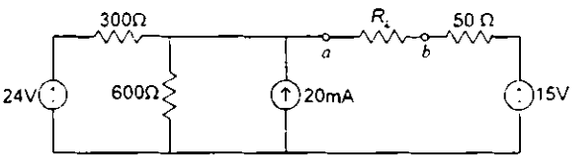


Figure 2

Answers:

i) V_T = _____

R_T = _____

iii) P_{max} = _____

iv) value correct ☐, R_L = _____

value incorrect ☐

Question 3 (20 marks)

For the RLC circuit of Figure 3, determine:

i) The energy stored in the capacitor and in the inductor before opening the switch.

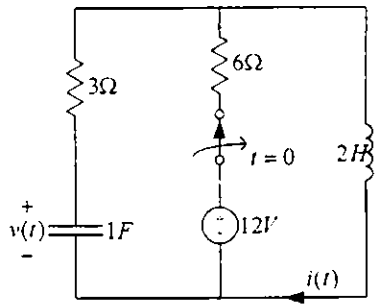


Figure 3

Energy in cap.=

Energy in ind.=

ii) The characteristic equation for the circuit for t>0.

iii) $v(t)$ for t>0.

iv) $i(t)$ for t>0.

Question 4 (20 marks)

A 1000 W electric motor is connected to a sinusoidal source of 120 V_{rms} at 60 Hz, Figure 4, which results in a lagging power factor (PF) of 0.75.

i) Calculate the current (rms value) drawn from the source.

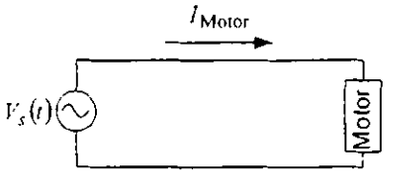


Figure 4

$I_{Motor}(rms)$ =

ii) The PF is now increased to 0.9 lagging by placing a capacitor in parallel with the motor, Figure 5. Calculate the new current (rms value) drawn from the source.

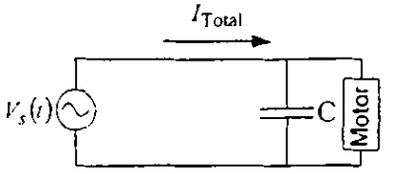


Figure 5

$I_{Total}(rms)$ =

iii) Determine the value of the capacitor required to make this correction.

C =

Question 5 (20 marks)

The network function T(s), input X(s) and output Y(s) of a linear circuit in S-domain are shown in Figure 6.

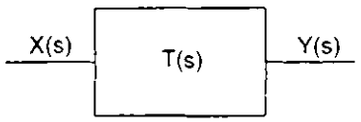


Figure 6

(8 marks) i) In time-domain, the output of the circuit y(t) when the input is an impulse δ(t), is

$$y(t) = \left(A_1 e^{-\alpha_1 t} + A_2 e^{-\alpha_2 t}\right) u(t),\ \alpha_1 \& \alpha_2 > 0$$

Calculate the network function T(s).

T(s) =

(12 marks) ii) Calculate steady-state output y(t), if the input signal is

$$x(t) = B_1 \cos(\omega_1 t) + B_2 \cos(\omega_2 t + \phi_2)$$

Question 6 (20 marks)

(7 marks) i) Find the voltage transfer function for the system of Figure 7.

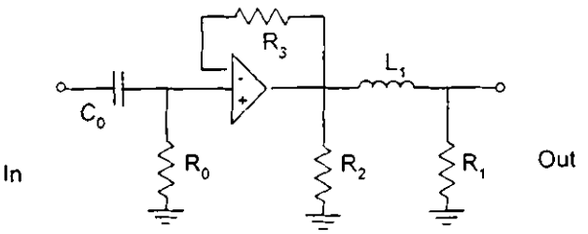
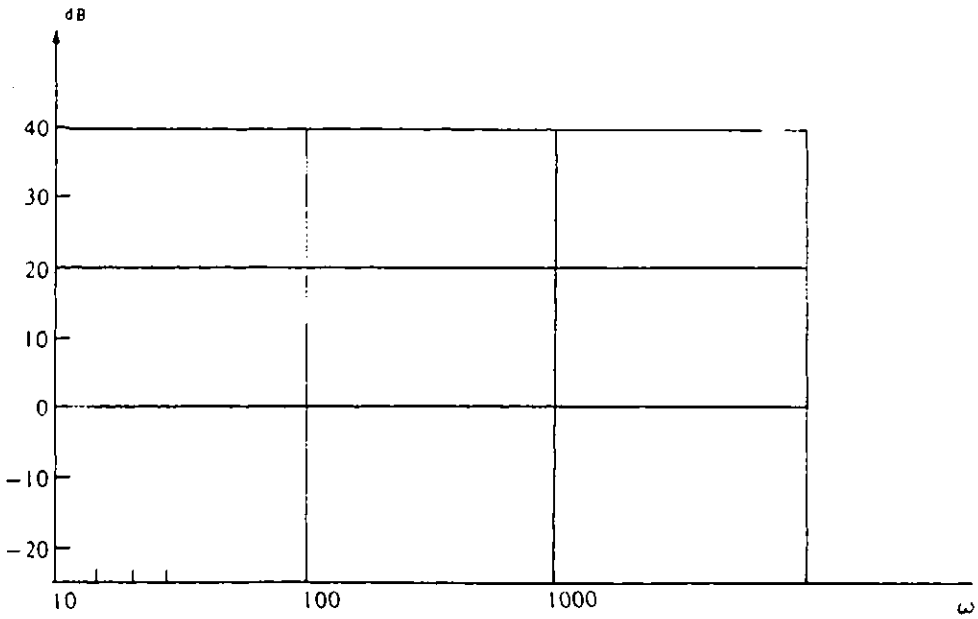


Figure 7

$T_v(S) =$

(7 marks) ii) If R_0C_0=0.01, R_2=R_3=50kΩ and R_1/L_1~2000, construct a plot of the straight-line approximation to the gain response of the circuit (20 log $|T|$ versus frequency).



(6 marks) iii) The circuit application requires that the upper cut-off frequency to be reduced to half of the value that can be determined in Section ii). If only one of the parameters C_0, R_3, R_2 and L_1 can be changed to achieve the application requirement, which one do you suggest to change, how (increase or decrease), and why?