Massachusetts Institute of Technology
Department of Electrical Engineering and Computer Science

6.200 – Circuits & Electronics
Spring 2026

Final Exam

20 May 2026

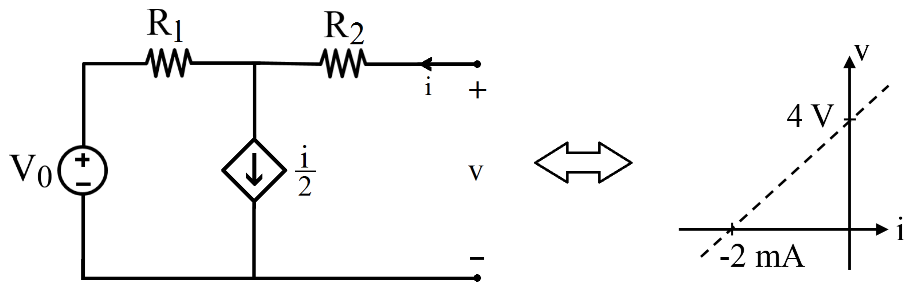
Name: ______________________________

MIT EMail: ____________________ @MIT.EDU

- There are 38 pages in this quiz, including this cover page.
- Please put your name and MIT EMail ID in the spaces provided above.
- Please do not remove any pages from this quiz.
- Do your work for each question within the boundaries of that question, or on the back of the preceding page.
- *This exam cannot be re-graded. Therefore, do your work in a neat and organized manner so that it can be easily understood. When finished with each part, clearly write your answer for that part into the corresponding answer box or graph.*
- *All numerical answers require proper units.*
- *In order to guarantee receipt of full credit, all answers should be justified by supporting math and/or explanations.*
- This is a closed-book closed-electronics quiz but a single two-sided page of notes is allowed.
- Good luck!

Problem 1: Unknown Parameters - 10%

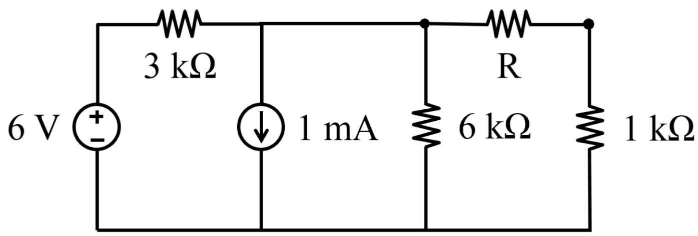
The network shown below comprises an independent voltage source, a dependent current source, and two resistors. All devices but the dependent current source have unknown values. The network also has a port at which the *i*-*v* relation is as shown below. Finally, it is known that R_1 dissipates 2 mW when $v = 0$. Using the information given, determine the unknown values V, R_1 and R_2.



$V_0 =$	$R_1 =$	$R_2 =$

Problem 2: Maximum Power Transfer - 10%

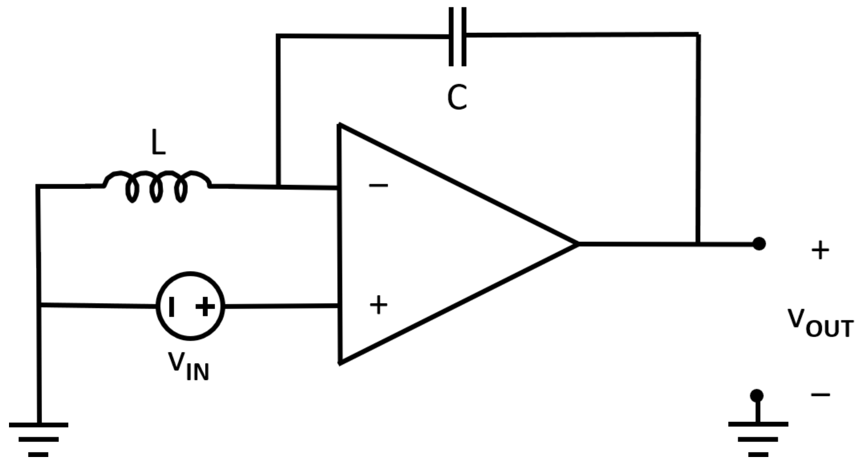
The network shown below contains a resistor having an unknown resistance R. Determine the numerical value of R that maximizes the power dissipated in that resistor. Additionally, determine the maximized power.



$R =$	Power $=$

Problem 3: Op Amp With LC Twice - 15%

Both parts of this problem concern the circuit shown below in which the op amp is ideal.



(3A) Let $v_{\text{IN}} = V\cos(\omega t)$. Further, assume that v_{OUT} has a zero-valued time average. Determine v_{OUT} in the sinusoidal steady state.

$v_{\text{OUT}} =$

(3B) Assume that for $t < 0$, $V_{IN} = 0$ so that the capacitor voltage and inductor current are both zero. Then, at $t = 0$, V_{IN} steps up to $V_{IN} = V$ where V is constant. Determine v_{OUT} for $t \geq 0$.

$v_{OUT} =$

Problem 4: RLC Transient - 25%

The circuit shown below is initially at rest such that $v_C = 0$ and $i_L = 0$ for $t < 0$. At $t = 0$, the current source steps up to $I = 1$ A. The figures shown below plot four waveforms within the circuit following the current step. Their horizontal axes all show time measured in seconds [s]. Their vertical axes show either voltage measured in Volts [V] or current measured in Amperes [A], as appropriate. *Note that the initial slopes of the waveforms in Figures 1 and 3 are positive, while the initial slopes of the waveforms in Figures 2 and 4 are zero.*

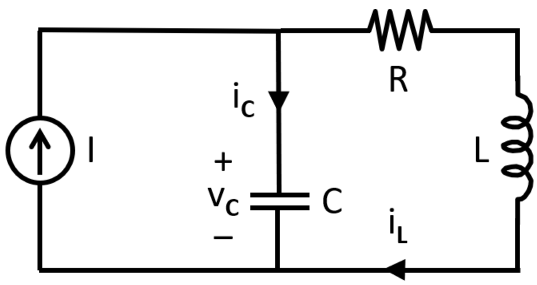


Figure 1

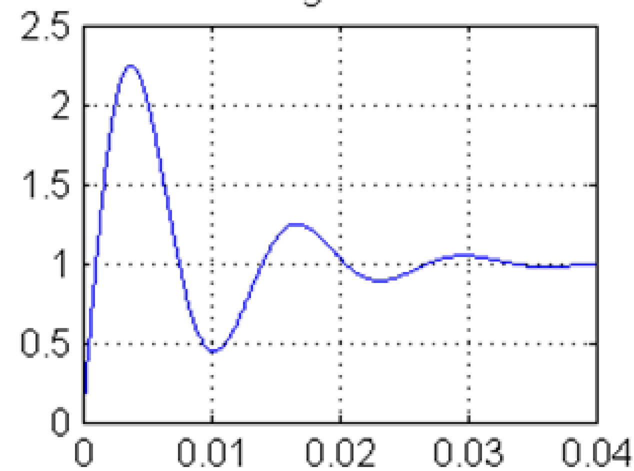


Figure 2

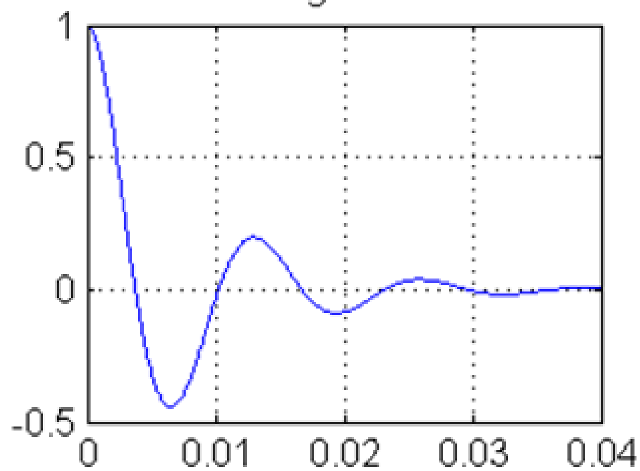


Figure 3

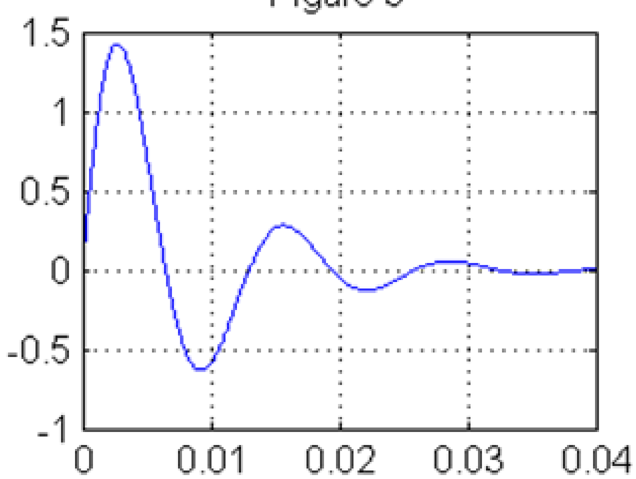
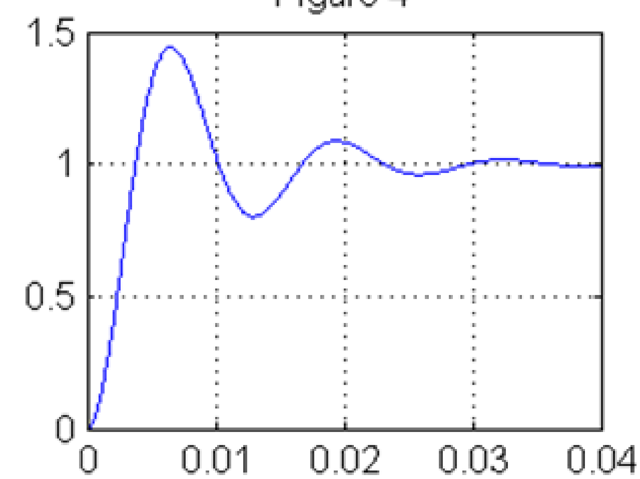


Figure 4



(4A) For each variable listed below, identify the corresponding figure by circling the figure number. *Briefly explain your reasoning in the space below.*

v_C	$\rightarrow$	Figure	1	2	3	4
i_C	$\rightarrow$	Figure	1	2	3	4
i_L	$\rightarrow$	Figure	1	2	3	4

Explain:

(4B) Estimate the value of R.

$R =$

(4C) Estimate the value of C.

$C =$

(4D) Estimate the value of L.

$L =$

(4E) Estimate the quality factor Q of the circuit.

$Q =$

(4F) For each statement below, circle the correct completion. *Briefly explain your reasoning in the space below.*

- If the resistance R is increased, the quality factor Q will $\cdots$

$\cdots$ increase.	$\cdots$ decrease.	$\cdots$ remain unchanged.

- If the capacitance C is increased, the quality factor Q will $\cdots$

$\cdots$ increase.	$\cdots$ decrease.	$\cdots$ remain unchanged.

- If the inductance L is increased, the quality factor Q will $\cdots$

$\cdots$ increase.	$\cdots$ decrease.	$\cdots$ remain unchanged.

Explain:

(4G) For each statement below, circle the correct completion. *Briefly explain your reasoning in the space below.*

- If the resistance R is increased, the period of oscillation will $\cdots$

$\cdots$ increase.	$\cdots$ decrease.	$\cdots$ remain unchanged.

- If the capacitance C is increased, the period of oscillation will $\cdots$

$\cdots$ increase.	$\cdots$ decrease.	$\cdots$ remain unchanged.

- If the inductance L is increased, the period of oscillation will $\cdots$

$\cdots$ increase.	$\cdots$ decrease.	$\cdots$ remain unchanged.

Explain:

(4H) After a long time T, the current source steps down to turn off. For each statement below concerning the subsequent decay of stored energy, circle the correct completion. *Briefly explain your reasoning in the space below.*

- If the resistance R is increased, the time at which the stored energy falls to half its value at time T will $\cdots$

$\cdots$ increase.	$\cdots$ decrease.	$\cdots$ remain unchanged.

- If the capacitance C is increased, the time at which the stored energy falls to half its value at time T will $\cdots$

$\cdots$ increase.	$\cdots$ decrease.	$\cdots$ remain unchanged.

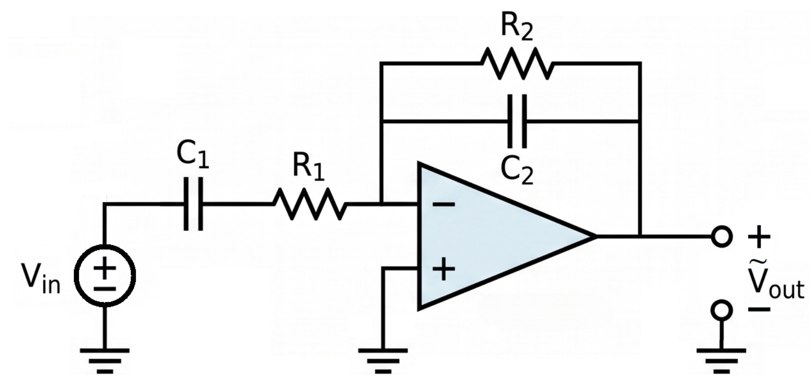
- If the inductance L is increased, the time at which the stored energy falls to half its value at time T will $\cdots$

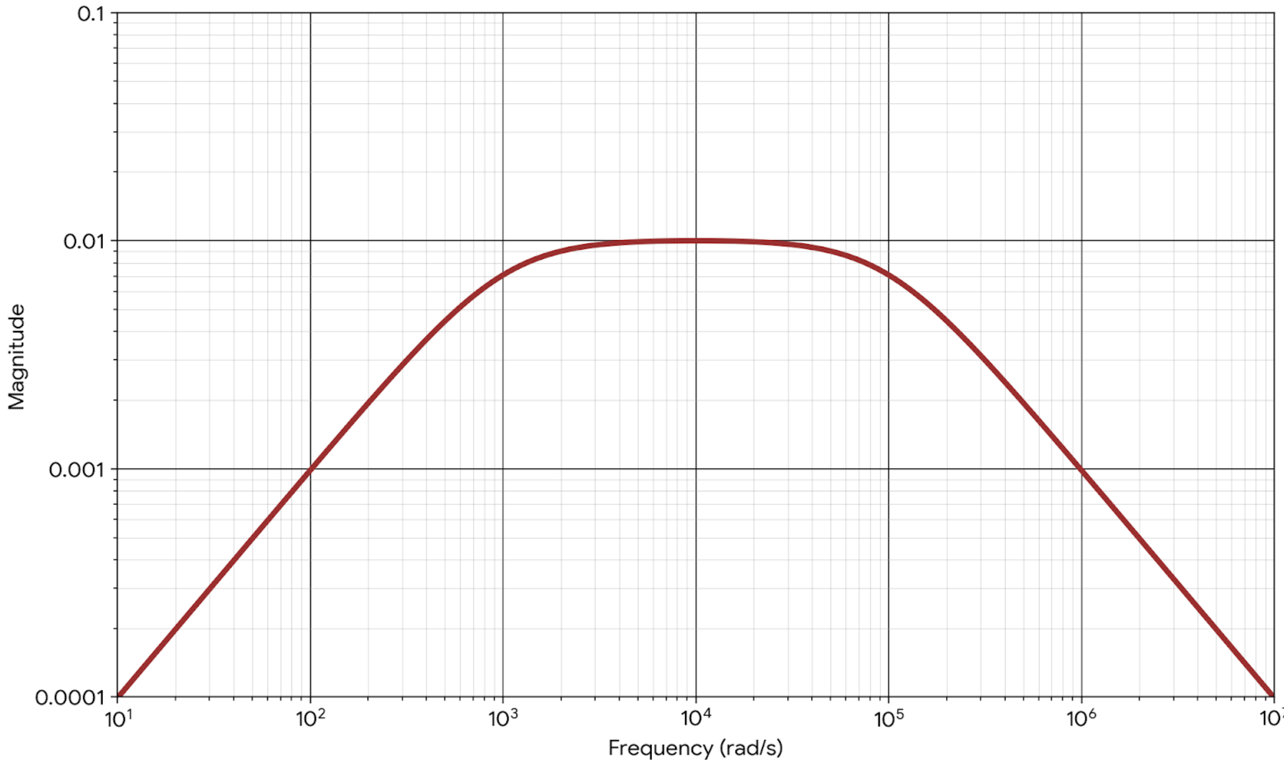
$\cdots$ increase.	$\cdots$ decrease.	$\cdots$ remain unchanged.

Explain:

Problem 5: RC Filter - 20%

This problem concerns the filter shown below together with a measurement of its transfer function.





(5A) Determine the symbolic transfer function $H(j\omega) \equiv \tilde{V}_{\text{out}}/\tilde{V}_{\text{in}}$ in terms of R_1, R_2, C_1, and C_2 where $\tilde{V}_{\text{in}}$ and $\tilde{V}_{\text{out}}$ are the complex amplitudes of $v_{\text{IN}}(t)$ and $v_{\text{OUT}}(t)$, respectively, when operating in the sinusoidal steady state.

$H(j\omega) =$

(5B) Assume that $C_1 = C_2 = 1\mu\text{F}$. Determine numerical values for R_1 and R_2 from the measured transfer function.

$R_1 =$	$R_2 =$

(5C) Suppose the filter is excited with the input $v_{\text{IN}}(t) = \tilde{V}_{\text{in}} \cos(\omega t + \phi)$, where $\tilde{V}_{\text{in}} = 5$ V, $\omega = 10^4$ rad/s, and $\phi = \pi/4$ rad. Determine a numerical expression for $v_{\text{OUT}}(t)$.

$V_{\text{out}} =$

Problem 6: Filter Design - 20%

This objective of this problem is to design an op-amp-based band-pass filter that implements the transfer function $H(j\omega)$ given by

$$H(j\omega) = \frac{\tilde{V}_{\text{out}}}{\tilde{V}_{\text{in}}} = \frac{\pm G(j\omega)\omega_\circ/Q}{(j\omega)^2 + (j\omega)\omega_\circ/Q + \omega_\circ^2}$$

where $\tilde{V}_{\text{in}}$ and $\tilde{V}_{\text{out}}$ are the complex amplitudes of the sinusoidal-steady-state input and output voltages, respectively, and G, $\omega_\circ$, and Q are pre-specified constants. The "±" in the transfer function indicates that both signs are acceptable.

The implementation of the transfer function should also observe the following constraints.

- The filter should be implemented with no more than two op amps, and no more than four capacitors, inductors and resistors in total.
- The op-amp(s) may be considered ideal, but any inductor should be considered imperfect due to a series resistance R given by $R = L/\tau$ where L is the inductance and τ is a known constant.
- Assume that the filter will be driven by a Thevenin equivalent. The operation of the filter should be independent of the resistance of that equivalent.
- The operation of the filter should be independent of any load attached to its output.

(6A) Draw the filter topology in space below, clearly labeling the symbolic component values.

Topology:

(6B) Derive expressions for the component (capacitor, inductor, resistor) values in terms of G, $\omega_\circ$, Q and τ. If the component values are under-specified, then pick one (or more) as being pre-specified until the remaining component values are uniquely specified. Be clear which component value is being specified below.

Component #1:	Value =
Component #2:	Value =
Component #3:	Value =
Component #4:	Value =
Under-specified component(s):	

(6C) Is the achievable Q limited given practical engineering constraints? If so, to what range? Circle the appropriate answer and provide a range if "Yes".

Yes	No	Range: