Midterm 1

ⓘ This is a preview of the published version of the quiz

Started: Oct 15 at 11:20pm

Quiz Instructions

Midterm 1 is open book. You are allowed to use any lecture/course notes, homeworks, discussions, or websites (except those for collaborative documents or forums). In addition to this, we will allow the use of a calculator and a Python File or Notebook. You may not access or post on any collaborative documents (e.g. Google Docs) or forums (e.g. Chegg). **Collaboration with other students is prohibited.**

Assuming you do not have an approved time extension, you will have 1 hour (60 minutes) to complete the Midterm and you may begin the Midterm at any point during the window of 7:10-8:30 pm. However, the Midterm will close at 8:30 pm, meaning that you must start by 7:30 pm to have the full 1 hour. **We are not Zoom proctoring.**

We will not clarify anything during the exam so please do your best with the information provided. If you have an issue during your exam please email us at **eecs16b-fa20@berkeley.edu (mailto:eecs16b-fa20@berkeley.edu)** and CC the professors (**seth.sanders@berkeley.edu (mailto:seth.sanders@berkeley.edu)** and **mlustig@eecs.berkeley.edu (mailto:mlustig@eecs.berkeley.edu)**).

Good luck!

Question 1 — 1 pts

Consider the following first-order differential equation

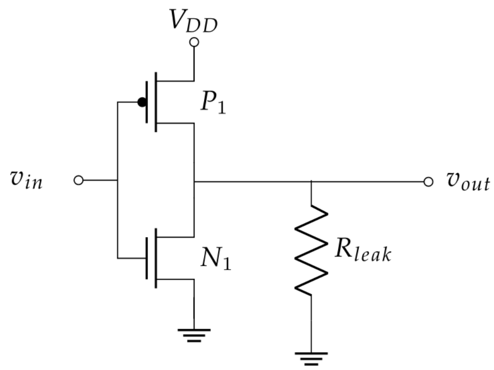
$$\frac{d}{dt}x(t) = 4x(t) \quad x(0) = 0;$$

What is the solution $x(t)$ to this differential equation?

- ○ e^{4t}
- ○ $1 - e^{4t}$
- ○ 0
- ○ e^{-4t}

Question 2

3 pts



A leaky inverter.

In the circuit shown, we have accidentally introduced a leakage resistance at the output of the inverter. **Use the resistor-switch model** to analyze the operation of this circuit, **ignore all capacitances.**

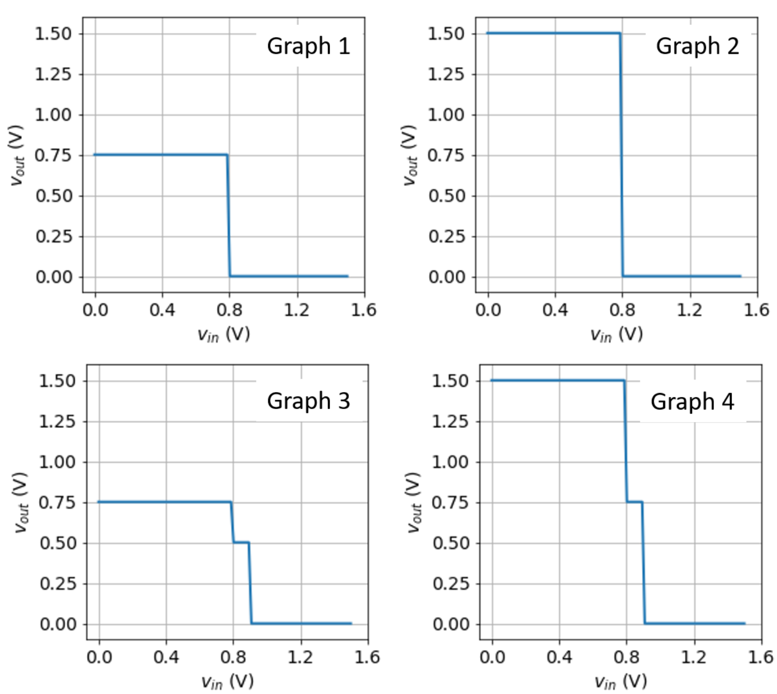
For the transistors, assume that $R_{ON,N} = R_{ON,P} = R_{leak}$ (transistors N_1 and P_1 have the same on resistance). The threshold voltages for the NMOS and PMOS transistors are $V_{tn} = 0.8V$ and $V_{tp} = -0.6V$ respectively. We are using $V_{DD} = 1.5V$.

Which of the following statements are **correct** for the operation of the inverter.

[Select] When $v_{in} < 0.5V$, transistor N_1 is ON (switch closed).

[Select] When $v_{in} > 1V$, transistor P_1 is OFF (switch open).

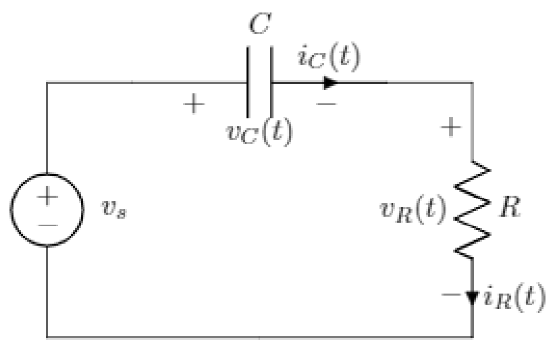
[Select] Pick the correct relationship between v_{in} and v_{out}.



Question 3

1 pts

Consider the following circuit with a capacitor that is initially charged with $v_C(t=0) = 10\text{V}$.



Let $v_s = 20\text{V}$, $C = 10\mu\text{F}$, $R = 20\text{k}\Omega$. What is the current passing through the capacitor after 1 second has passed?

$i_C(t=1) =$

- $1.993 \cdot 10^6 A$
- $9.97 \cdot 10^{-4} A$
- $0.135A$
- $19.93A$
- $3.37 \cdot 10^{-6} A$

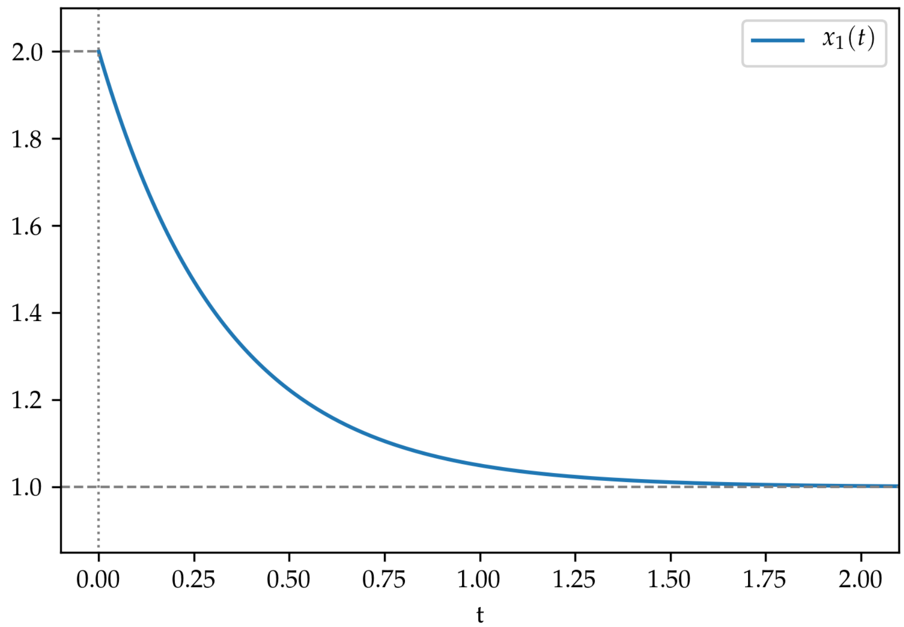
Question 4

1 pts

Suppose we have the vector differential equation

$\frac{d}{dt}\vec{x}(t) = A\vec{x}(t)$, where $A = \begin{bmatrix} -4 & 2 \\ -2 & 1 \end{bmatrix}$.

Suppose the plot of $x_1(t)$ is given below with $\lim_{t\to\infty} x_1(t) = 1$, what is $x_2(t)$ when you take the limit as $t \to \infty$?



Hint: Think carefully about eigenvalue-eigenvector pairs.

- ◯ Not enough information is given to find $\lim_{t \to \infty} x_2(t)$
- ◯ 1/2
- ◯ 1
- ◯ 2

Question 5

1 pts

What is the polar form of the following complex number?

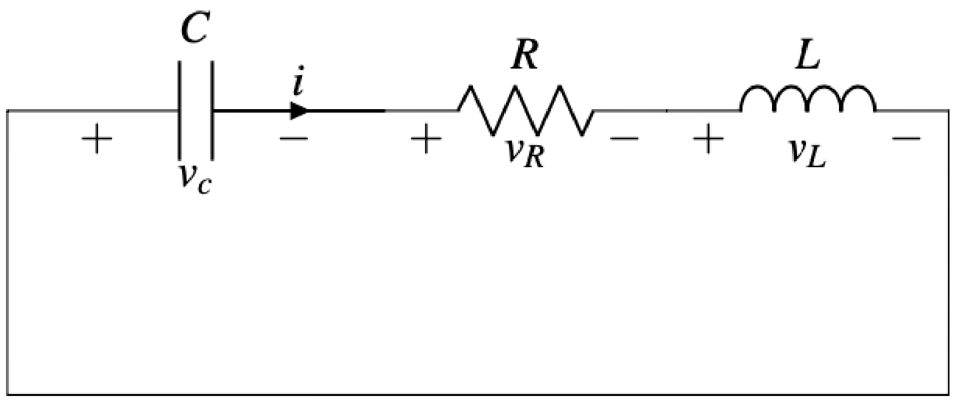
$z = -\sqrt{3} - \frac{1}{j}$

- ◯ $2e^{j\frac{5\pi}{6}}$
- ◯ $4e^{j\frac{2\pi}{3}}$
- ◯ $4e^{j\frac{5\pi}{6}}$
- ◯ $2e^{j\frac{2\pi}{3}}$

Question 6

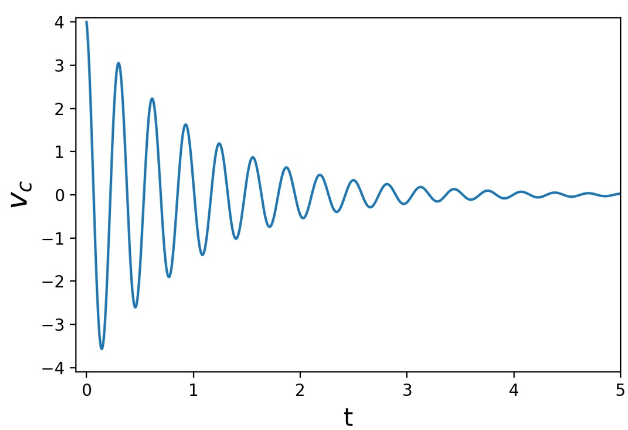
2 pts

Consider the following RLC circuit with unknown values of $R, L, C > 0$ and unknown initial conditions.

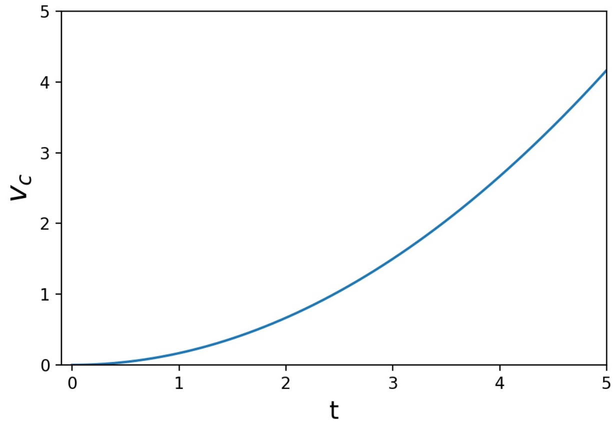


Mark all of the following plots of $v_c(t)$ that are **possible.**

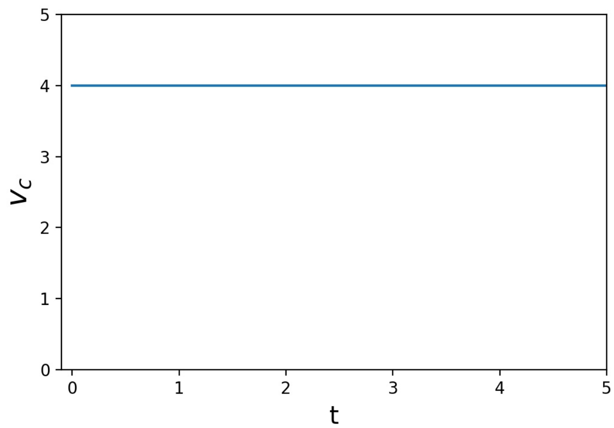
Plot 1: [Select]



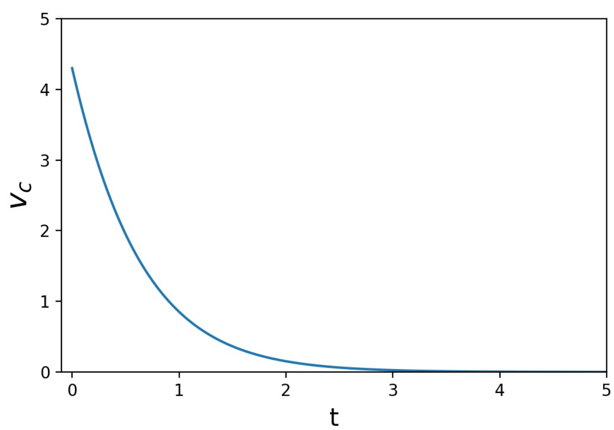
Plot 2: [Select]



Plot 3: [Select]



Plot 4: [Select]



Question 7

1 pts

What is the phasor for the following time wave form?

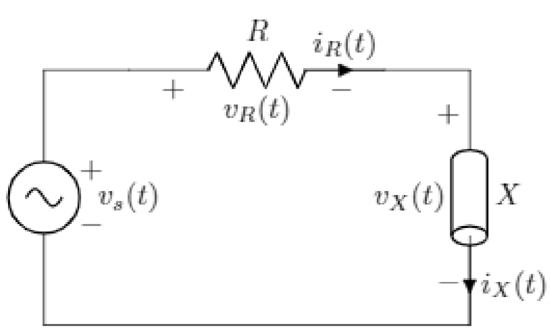
$i(t) = 2\sin(\omega t - \frac{\pi}{6})$

- $2e^{-j\frac{5\pi}{6}}$
- $2e^{j\frac{\pi}{6}}$
- $2e^{j\frac{2\pi}{3}}$
- $2e^{-j\frac{\pi}{6}}$
- $2e^{-j\frac{2\pi}{3}}$

Question 8

1 pts

Consider the below circuit which incorporates a novel circuit device X whose impedance is of the form $Z_X = -\dfrac{1}{\omega^3 X}$:



Where $v_s(t) = 4\cos(10t + \frac{\pi}{4}), R = 10\mu\Omega, X = 200$ with units appropriate to fit the above equation. What is the steady state output voltage of $v_X(t)$?

- $v_X(t) = 2\cos\left(100t + \frac{\pi}{4}\right)$
-

$v_X(t) = 2\cos\left(10t - \frac{\pi}{4}\right)$

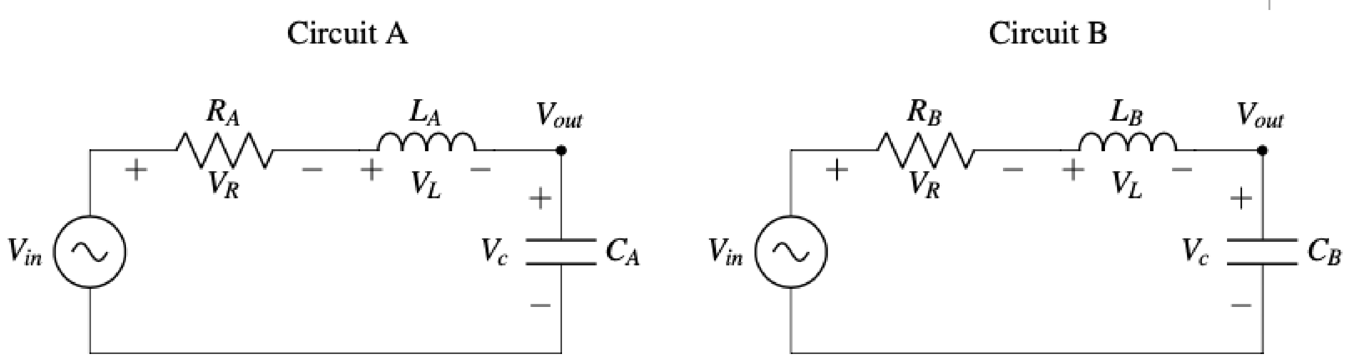
○ $v_X(t) = -4\cos\left(10t + \frac{\pi}{4}\right)$

○ $v_X(t) = 8\cos\left(10t - \frac{\pi}{4}\right)$

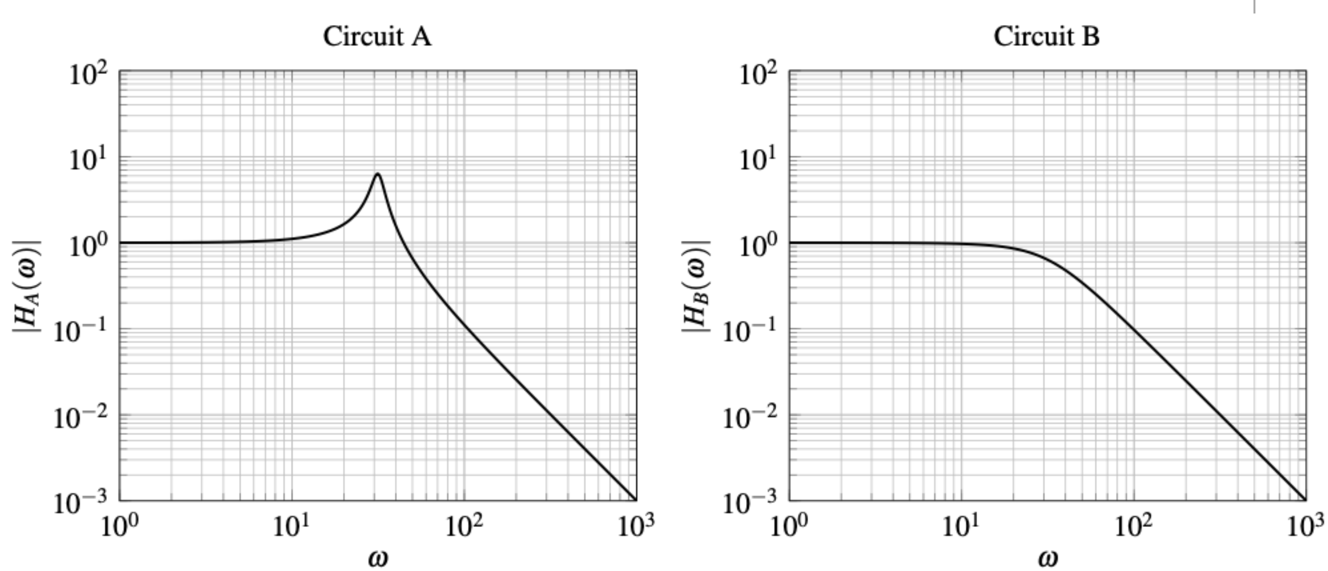
Question 9

2 pts

Consider two RLC circuits A and B with sinusoidal inputs that have different R, L, and C values.



Defining the transfer function $H(\omega) = \frac{V_{out}}{V_{in}}$, the magnitude Bode plots of both circuits' transfer functions are shown below.



Mark all of the following statements that are **true.**

i. Circuit A has a lower quality factor Q than Circuit B. [Select]

ii. Increasing R_A in circuit A will increase its quality factor Q.

[Select]

iii. Decreasing R_B in circuit B may cause a resonant peak to occur.

[Select]

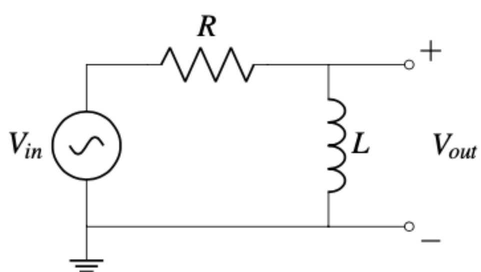
iv. Increasing C in either circuit will decrease its respective quality factor Q.

[Select]

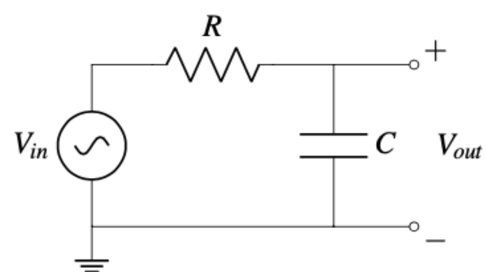
Question 10

1 pts

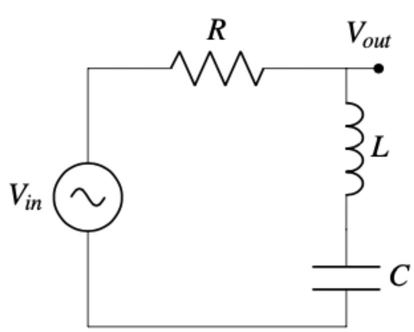
Given the following tasks, pick the circuit best suited for each task. Each task will have **exactly one** circuit that matches it the best.



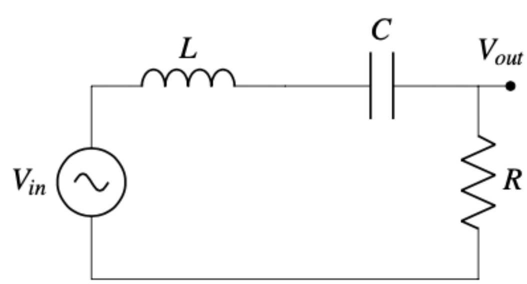
RL Circuit



RC Circuit



RLC Circuit



LCR Circuit

Filtering out noise with frequency larger than 20 kHz.	[Choose]
Receiving a transmitted signal in between 2.3GHz and 2.7GHz.	[Choose]
Decreasing the amount of bass (lower frequencies) in your sound system.	[Choose]
Blocking out the 60 Hz frequency from your wall-power while letting all other frequencies through.	[Choose]

Question 11

2 pts

$$H(\omega) = 100\frac{\left(1+j\frac{\omega}{100}\right)(1+j\omega\cdot 10)}{(1000+j\omega)(1+j\omega)}$$

Below, we have some statements about the magnitude and phase of the transfer function given above. For **(i), (ii) and (iii) state if the statements are True/False.** For **(iv), pick the correct graph.**

[Select] As $\omega \to 0$, the magnitude $|H(\omega)| \to 100$.

[Select] As $\omega \to \infty$, the magnitude $|H(\omega)| \to \infty$.

[Select] At $\omega = 1$, $\angle H(\omega) \approx -\frac{\pi}{4}$

[Select] Pick the correct graph for the magnitude response $|H(\omega)|$

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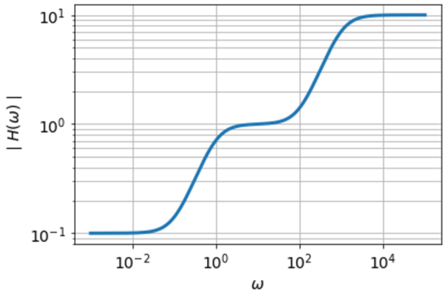
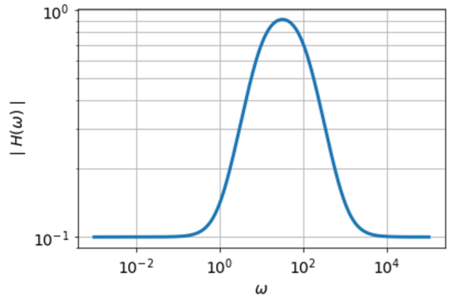
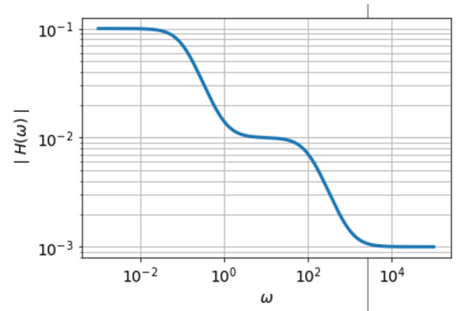


Graph 1



Graph 2



Graph 3

Not saved Submit Quiz