

Name _____
(1 point)

Grade = _____ /100

ECE 2040 Midterm Exam 2
Spring 2019

Each question is worth 3 points.

All of your answers need to be on this sheet.

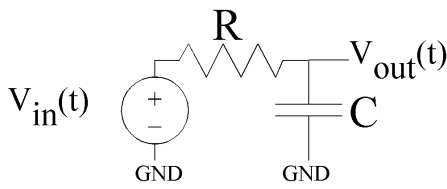
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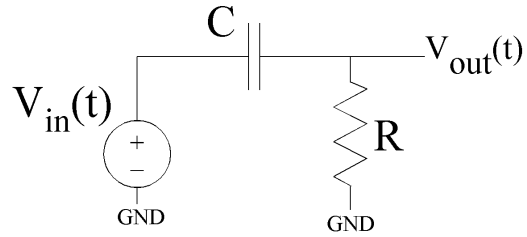
Choose the *best possible answer* available in all cases.

- | | | |
|-----------|-----------|-----------|
| 1. _____ | 12. _____ | 23. _____ |
| 2. _____ | 13. _____ | 24. _____ |
| 3. _____ | 14. _____ | 25. _____ |
| 4. _____ | 15. _____ | 26. _____ |
| 5. _____ | 16. _____ | 27. _____ |
| 6. _____ | 17. _____ | 28. _____ |
| 7. _____ | 18. _____ | 29. _____ |
| 8. _____ | 19. _____ | 30. _____ |
| 9. _____ | 20. _____ | 31. _____ |
| 10. _____ | 21. _____ | 32. _____ |
| 11. _____ | 22. _____ | 33. _____ |

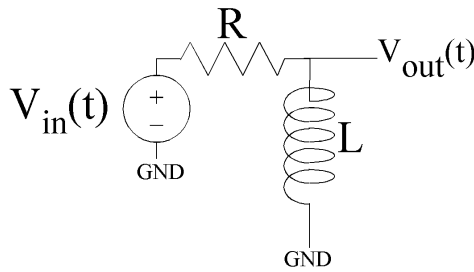
Use the following circuit diagrams for the following questions: ($R = 10\text{k}\Omega$, $C = 100\text{nF}$, $L = 100\text{mH}$). Choose the most correct answers.



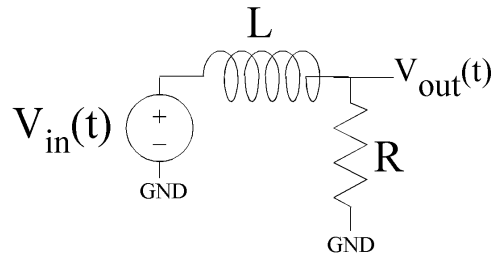
(a)



(b)



(c)



(d)

1. What is the timeconstant for circuit (a)?

- a. 0.01ms
- b. 0.1ms
- c. 1ms
- d. 10ms
- e. 100ms

2. What is the timeconstant for circuit (d)?

- a. 0.001ms
- b. 0.01ms
- c. 0.1ms
- d. 1ms
- e. 10ms

3. For a 1V step input ($V_{in} = 1\text{V } u(t)$) for circuit (a), what is the steady state ($t \rightarrow \infty$) output voltage (V_{out})?

- a. -1V
- b. -100mV
- c. 0V
- d. 100mV
- e. 1V

4. For a 1V step input ($V_{in} = 1\text{V } u(t)$) for circuit (b), what is the steady state ($t \rightarrow \infty$) output voltage (V_{out})?

- a. -1V
- b. -100mV
- c. 0V
- d. 100mV
- e. 1V

5. For a 1V step input ($V_{in} = 1\text{V } u(t)$) for circuit (d), what is the steady state ($t \rightarrow \infty$) output voltage (V_{out})?

- a. -1V
- b. -100mV
- c. 0V
- d. 100mV
- e. 1V

6. For a 1V step input ($V_{in} = 1\text{V } u(t)$) for circuit (b), what is the initial output voltage (V_{out}) after the step ($t=0^+$)?

- a. -1V
- b. -100mV
- c. 0V
- d. 100mV
- e. 1V

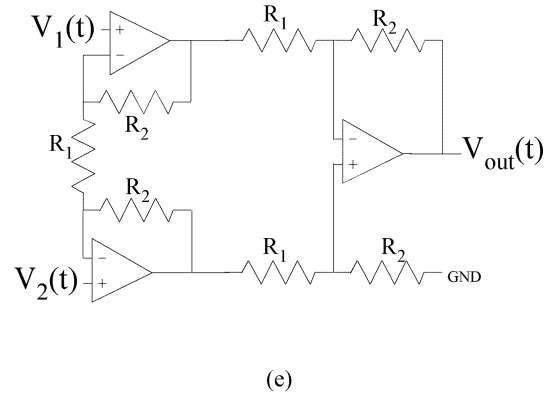
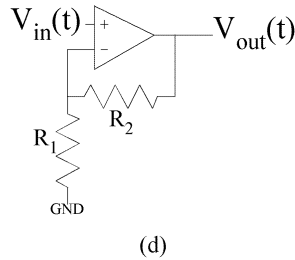
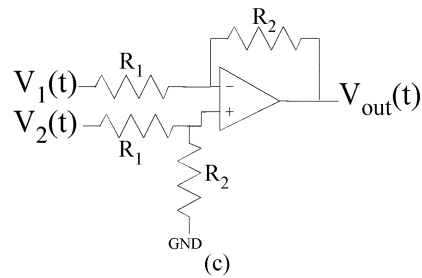
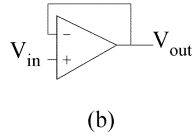
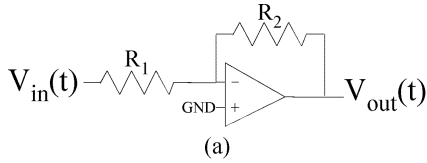
7. For a 1V step input ($V_{in} = 1\text{V } u(t)$) for circuit (c), what is the initial output voltage (V_{out}) after the step ($t=0^+$)?

- a. -1V
- b. -100mV
- c. 0V
- d. 100mV
- e. 1V

8. For a 1V step input ($V_{in} = 1\text{V } u(t)$) for circuit (d), what is the initial output voltage (V_{out}) after the step ($t=0^+$)?

- a. -1V
- b. -100mV
- c. 0V
- d. 100mV
- e. 1V

Use the following circuit diagrams for the following questions ($R_1 = 10\text{k}\Omega$, $R_2 = 100\text{k}\Omega$, Op-Amp gain is infinite):



9. What is the gain (V_{out}/V_{in}) for circuit (b)?

- a. 1
- b. 2
- c. 4
- d. 8
- e. 16

10. What is the gain (V_{out}/V_{in}) for circuit (a)?

- a. -11
- b. -10
- c. 1
- d. 10
- e. 11

11. What is the resistance looking into V_{in} for circuit (a)?

- a. $1\text{k}\Omega$
- b. $10\text{k}\Omega$
- c. $100\text{k}\Omega$
- d. $1000\text{k}\Omega$
- e. Infinite

12. What is the gain ($V_{out}/(V_2-V_1)$) for circuit (c)?

- a. -11
- b. -10
- c. 1
- d. 10
- e. 11

13. What is the gain (V_{out}/V_{in}) for circuit (d)?

- a. -11
- b. -10
- c. 1
- d. 10
- e. 11

14. What is the resistance looking into V_{in} for circuit (b)?

- a. $1\text{k}\Omega$
- b. $10\text{k}\Omega$
- c. $100\text{k}\Omega$
- d. $1000\text{k}\Omega$
- e. Infinite

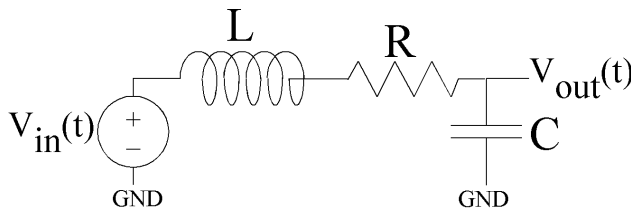
15. What is the magnitude of the gain ($V_{out}/(V_2-V_1)$) for circuit (e)?

- a. 1
- b. 3
- c. 10
- d. 30
- e. 100

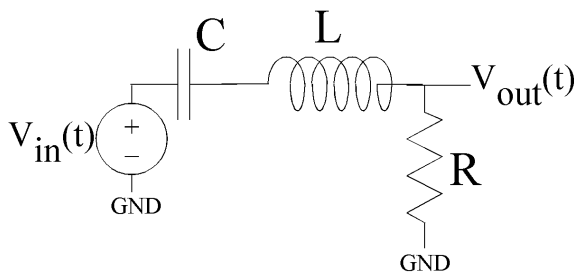
Select the Laplace Transform Pairs for the following questions using the potential answers given. Assume initial states, if required, are 0.

- | | | | | |
|-------------------------------|----|-------------------------------------|----|-------------------------------------|
| 16. $u(t)$ | a. | 1 | f. | $\frac{1}{s}$ |
| 17. $\frac{df(t)}{dt}$ | b. | $\frac{1}{s(s+a)}$ | g. | $\lim_{t \rightarrow 0} sF(s)$ |
| 18. $\int f(t)dt$ | c. | $\lim_{t \rightarrow \infty} sF(s)$ | h. | $\frac{s}{s^2 + \omega_1^2}$ |
| 19. $e^{-at}u(t)$ | d. | $\frac{1}{s+a}$ | i. | $\frac{\omega_1}{s^2 + \omega_1^2}$ |
| 20. $f(t \rightarrow \infty)$ | e. | $\frac{1}{s}F(s)$ | j. | $sF(s)$ |
| 21. $\sin(\omega_1 t)$ | | | | |

22. $H(s) = \frac{V_{out}(s)}{V_{in}(s)} = \frac{s\tau}{1+s\tau}$, and $V_{in} = u(t)$, what is $V_{out}(t)$?
23. $H(s) = \frac{V_{out}(s)}{V_{in}(s)} = \frac{1}{1+s\tau}$, and $V_{in} = u(t)$, what is $V_{out}(t)$?
- | | |
|---|---|
| a. $V_{out}(t) = 1$ | a. $V_{out}(t) = 1$ |
| b. $V_{out}(t) = u(t)$ | b. $V_{out}(t) = u(t)$ |
| c. $V_{out}(t) = (1 - e^{-t/\tau})u(t)$ | c. $V_{out}(t) = (1 - e^{-t/\tau})u(t)$ |
| d. $V_{out}(t) = e^{-t/\tau}u(t)$ | d. $V_{out}(t) = e^{-t/\tau}u(t)$ |
| e. $V_{out}(t) = \tau e^{-t/\tau}u(t)$ | e. $V_{out}(t) = \tau e^{-t/\tau}u(t)$ |



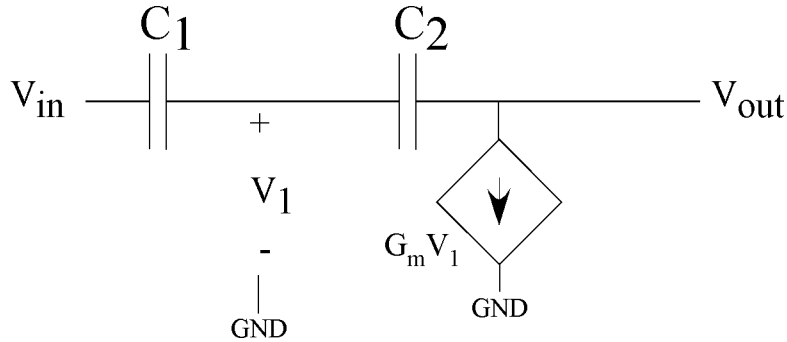
(a)



(b)

24. For circuit (a), what is the gain (V_{out}/V_{in}) in Laplace domain?
25. For circuit (b), what is the gain (V_{out}/V_{in}) in Laplace domain?
- | | |
|--------------------------------|--------------------------------|
| a. 1 | a. 1 |
| b. $\frac{1}{sRC+1}$ | b. $\frac{1}{sRC+1}$ |
| c. $\frac{1}{s^2LC+sRC+1}$ | c. $\frac{1}{s^2LC+sRC+1}$ |
| d. $\frac{sRC}{s^2LC+sRC+1}$ | d. $\frac{sRC}{s^2LC+sRC+1}$ |
| e. $\frac{s^2LC}{s^2LC+sRC+1}$ | e. $\frac{s^2LC}{s^2LC+sRC+1}$ |
26. For circuit (a), what is the gain (V_{out}/V_{in}) at steady state after a 1V step ($1V u(t)$)?
27. For circuit (b), what is the gain (V_{out}/V_{in}) at steady state after a 1V step ($1V u(t)$)?
- | | |
|-----------|-----------|
| a. -1V | a. -1V |
| b. -300mV | b. -300mV |
| c. 0 | c. 0 |
| d. 300mV | d. 300mV |
| e. 1V | e. 1V |

The following questions relate to the circuit below. $C_1 = 1\text{pF}$, $C_2 = 100\text{fF}$, $1/G_m = 1\text{M}\Omega$, $R_L = 1\text{G}\Omega$.



28. How many state variables in this circuit?

- a. 0
- b. 1
- c. 2
- d. 3
- e. 4

31. For a 10mV step in the input ($10\text{mV } u(t)$), the change in V_{out} at steady state ($t \rightarrow \text{infinity}$) would be positive (T=A, F=B). Assume $V_{\text{out}} = 0$ for $V_{\text{in}} = 0$, at $t=0^-$.

29. What is the time constant for this circuit?

- a. 1ns
- b. 10ns
- c. 100ns
- d. 1000ns
- e. 10000ns

32. Assume $V_{\text{out}} = 0$ for $V_{\text{in}} = 0$, at $t=0^-$. For a 10mV step in the input ($10\text{mV } u(t)$), the magnitude change in V_{out} at steady state ($t \rightarrow \text{infinity}$) would be

- a. 0mV
- b. 3mV
- c. 10mV
- d. 30mV
- e. 100mV

30. For an input voltage of 0V, one could get an output voltage of 1V. (T=A/F=B).

33. Assume $V_{\text{out}} = 0$ for $V_{\text{in}} = 0$, at $t=0^-$. For a 10mV step in the input ($10\text{mV } u(t)$), the magnitude change in V_{out} after the step ($t \rightarrow 0^+$) would be

- a. 0mV
- b. 3mV
- c. 10mV
- d. 30mV
- e. 100mV

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- | | | |
|--------------|--------------|--------------|
| 1. <u>c</u> | 12. <u>d</u> | 23. <u>c</u> |
| 2. <u>b</u> | 13. <u>e</u> | 24. <u>c</u> |
| 3. <u>e</u> | 14. <u>e</u> | 25. <u>d</u> |
| 4. <u>c</u> | 15. <u>e</u> | 26. <u>e</u> |
| 5. <u>e</u> | 16. <u>f</u> | 27. <u>c</u> |
| 6. <u>e</u> | 17. <u>j</u> | 28. <u>b</u> |
| 7. <u>e</u> | 18. <u>e</u> | 29. <u>c</u> |
| 8. <u>c</u> | 19. <u>d</u> | 30. <u>A</u> |
| 9. <u>a</u> | 20. <u>g</u> | 31. <u>B</u> |
| 10. <u>b</u> | 21. <u>i</u> | 32. <u>e</u> |
| 11. <u>b</u> | 22. <u>d</u> | 33. <u>a</u> |