MATHEMATICAL QUESTIONS

Question 1

Design a circuit with the lowest number of op-amps that implements $v_o(t) = -4v_{s1}(t) + 7v_{s2}(t)$.

Question 2

Consider the non-inverting amplifier shown in Fig. 1(a).

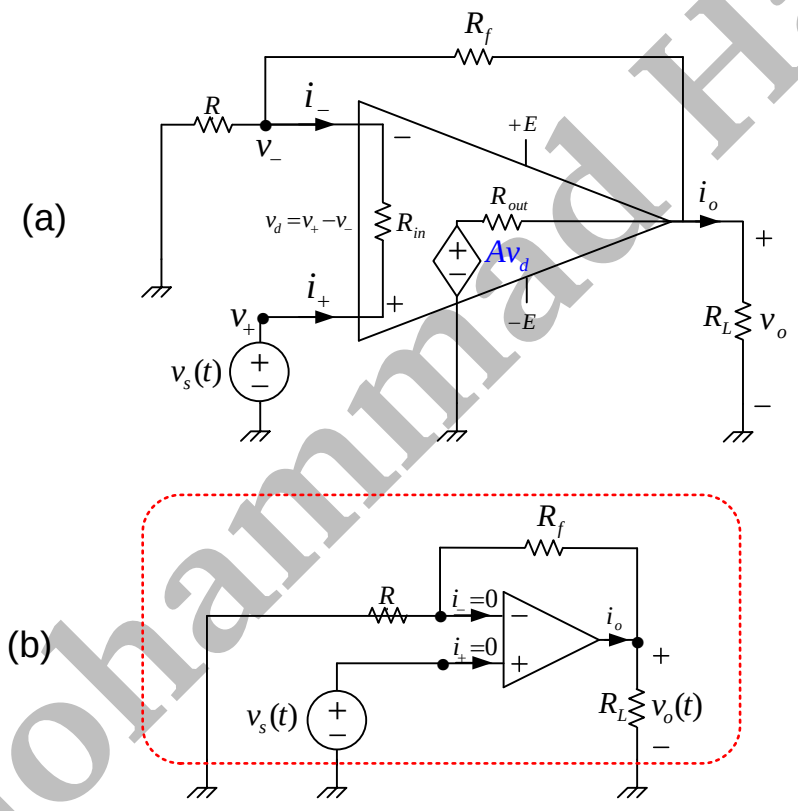

Figure 1: A non-inverting amplifier.

(a) Calculate $G = \frac{v_o}{v_s}$ in Fig. 1(a).

Question 2 continued on next page...

(b) Under which conditions the calculated $G = \frac{v_o}{v_s}$ equals the gain of ideal non-inverting amplifier in Fig. 1(b)?

(c) Do the currents crossing the red closed surface of Fig. 1(b) constitute a KCL?

Question 3

Consider the circuit shown in Fig. 2, where V_{ref} is provided by a regulated voltage source. Show that the circuit can act like a current source and find the constant current I_s flowing to the resistive load R_L.

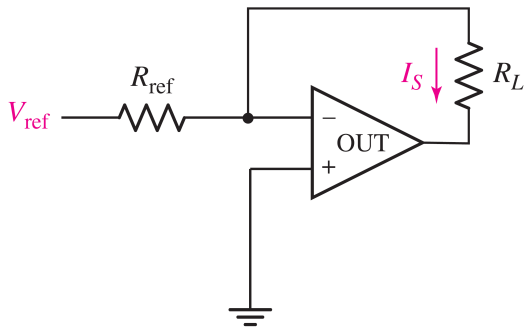

Figure 2: An op amp-based current source.

Question 4

Apply a unit-step function, $x(t) = u(t)$, as the input to a system whose impulse response is $h(t) = u(t) - 2u(t-1) + u(t-2)$, and determine the corresponding output $y(t) = x(t) * h(t)$.

Question 4 continued on next page...

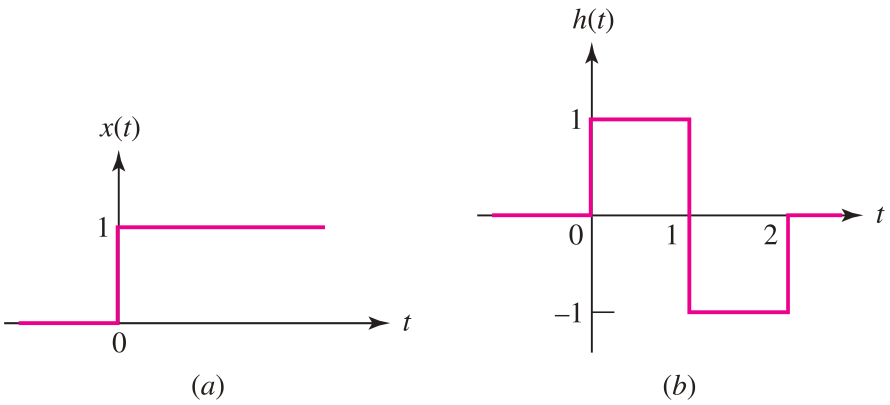

Figure 3: Sketches of (a) the input signal and (b) the unit impulse response for a linear system.

Question 5

Find the convolution of the two exponential signals $e^{-\alpha t}u(t)$ and $e^{-\beta t}u(t)$. Feel free to use graphical, analytical, or any other method you know.

Question 6

Consider a series RL circuit driven with the voltage source $v(t)$, where the loop current $i(t)$ should be calculated.

(a) Find the zero-input response if the initial current is $i(0) = I_0$.

(b) Find the step response.

(c) Find the impulse response.

(d) Find the zero-state response if $v(t) = V_0 e^{-t}u(t)$.

Question 6 continued on next page...

(e) Find the complete response if $v(t) = V_0 e^{-t} u(t)$ *and* $i(0) = I_0$.

SOFTWARE QUESTIONS

Question 7

Simulate a non-inverting amplifier with the gain 2 **and an inverting amplifier with the gain** -2 **in PSpice. Use LM324 for the op amp. Apply a suitable periodic voltage to each amplifier and investigate the corresponding output. Increase the frequency and amplitude of the input and observe the results.**

BONUS QUESTIONS

Question 8

Repeat Question 6 if $v(t) = V_0 \cos(\omega t + \theta) u(t)$**.**

Question 9

Return your answers by filling the LaTeXtemplate of the assignment.

EXTRA QUESTIONS

Question 10

Feel free to solve the following questions from the book *"Engineering Circuit Analysis"* by W. Hayt, J. Kemmerly, and S. Durbin.

1. **Chapter 6, question 12.**
2. **Chapter 6, question 13.**

Question 10 continued on next page...

3. **Chapter 6, question 14.**
4. **Chapter 6, question 17.**
5. **Chapter 6, question 20.**
6. **Chapter 6, question 21.**
7. **Chapter 6, question 23.**
8. **Chapter 6, question 28.**
9. **Chapter 6, question 29.**
10. **Chapter 6, question 34.**
11. **Chapter 6, question 38.**
12. **Chapter 6, question 40.**
13. **Chapter 6, question 45.**