EE 350 **EXAM I** **14 FEB 2000**

Name: ____________________________

ID#: ____________________________

Section: _______

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Problem	Weight	Score
1	25	
2	25	
3	25	
4	25	
Total	100	

Test Form A

This test consists of four problems. Answer each problem on the exam itself; if you use additional paper, repeat the identifying information above, and staple it to the rest of your exam when you hand it in.

Problem 1: (25 Points)

1. (10 points) Consider the signal $f(t)$ shown in Figure 1. Sketch the signals

$$g(t) = f(-2\,t)$$

and

$$h(t) = f(3 - 2\,t)$$

using the graphs provided in Figure 2.

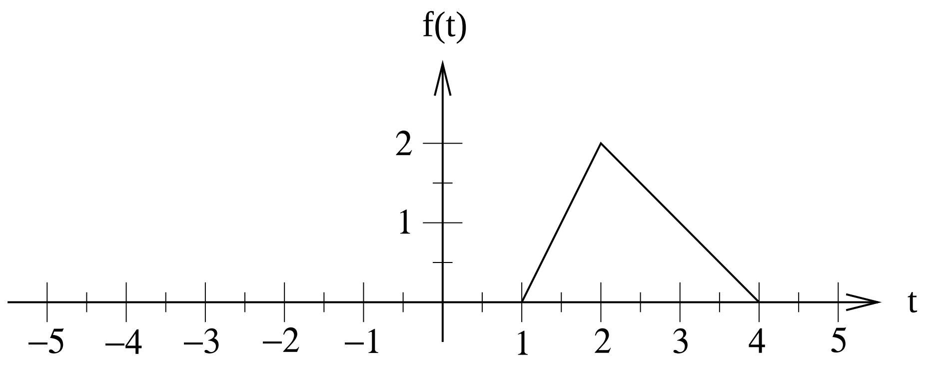


Figure 1: The signal $f(t)$.

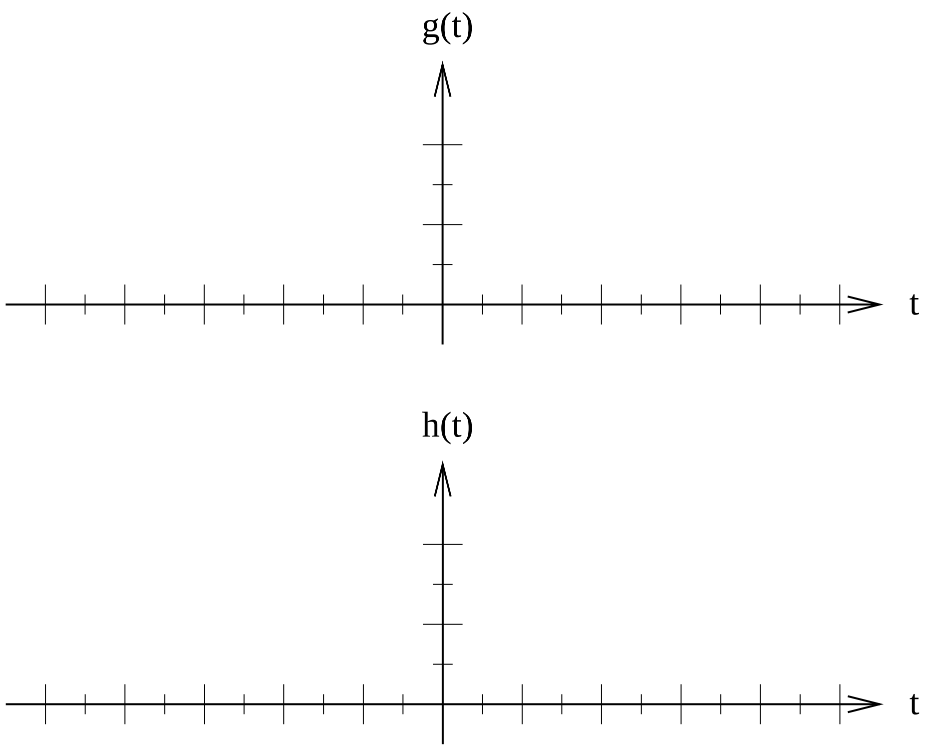


Figure 2: Blank graphs for sketching $g(t)$ and $h(t)$.

2. (5 Points) Express the function

$$f(t) = e^{-t}\ u(t)$$

as the sum of an even function $f_e(t)$ and an odd function $f_o(t)$.

3. (10 Points) The circuit shown in Figure 3 is driven by an independent voltage source with amplitude

$$f(t) = 8e^{-2t}\ u(t) \quad \text{V}.$$

Determine the energy (in Joules) that is dissipated as heat in the resistor R_1 over the time interval

$$0 \leq t \leq \frac{\ln(2)}{4} \ \text{s}.$$

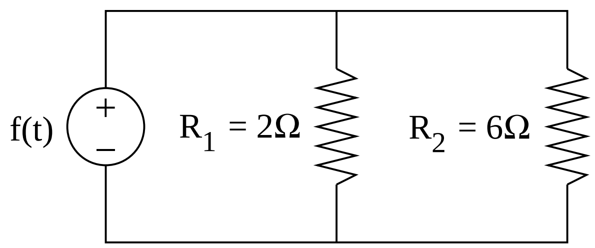


Figure 3: Resistive circuit with independent voltage source $f(t)$.

Problem 2: (25 points)

1. (10 points) When applied to a linear time-invariant (LTI) system, the input $f(t)$ shown in Figure 4(a) results in a zero-state response $y(t)$. A new input $f_1(t)$ shown in Figure 4(b) is applied to the same LTI system. Express the resulting zero-state response $y_1(t)$ in terms of $y(t)$.

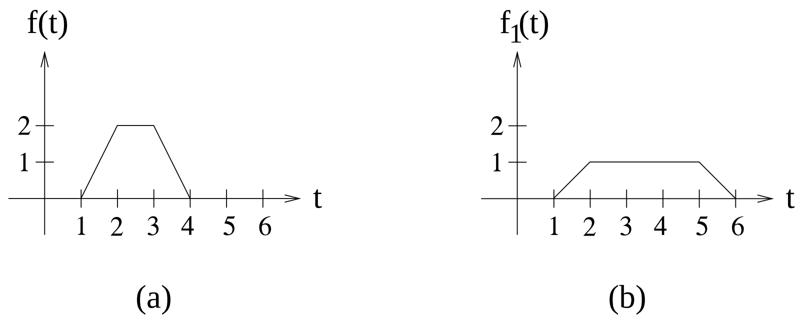


Figure 4: Inputs $f(t)$ and $f_1(t)$.

2. (6 points) Give an example of a system that is both dynamic and noncausal. Write the mathematical description of the system and indicate why it is dynamic and noncausal.

3. (9 points) A second order LTI system with input $f(t)$ and output $y(t)$ is specified by the ODE

$$\frac{d^2y}{dt^2} + 2\,\frac{dy}{dt} - 8\,y(t) = 10\,f(t).$$

Determine whether the system is asymptotically stable or unstable.

Problem 3: (25 points)

The circuit shown in Figure 5 with input $f(t)$ and output $y(t)$ is described by the ODE

$$\frac{dy}{dt} + 3000\, y(t) = \frac{1}{4}\frac{df}{dt}.$$

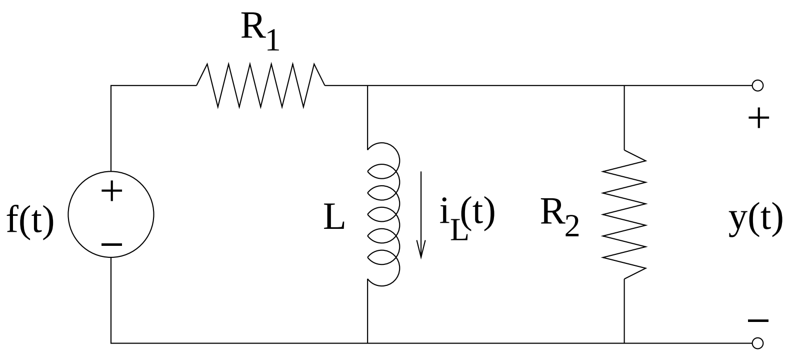


Figure 5: Circuit with input $f(t)$ and output $y(t)$.

1. (8 points) Assume that $R_1 = 300\ \Omega$, $R_2 = 100\ \Omega$, $L = 25$ mH, and the initial inductor current $i_L(0)$ is 40 mA. Find the zero-input response of the circuit for $t \geq 0$.

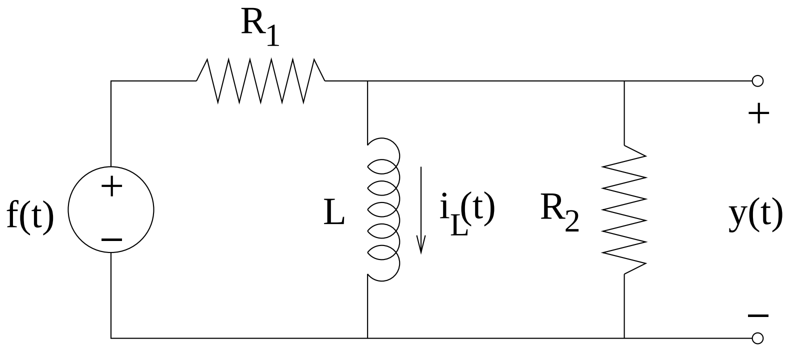
2. (3 points) When a system is strictly proper, that is, when the order n of $Q(D)$ is greater than the order m of $P(D)$, the zero-state response $y_{zs}(t)$ at time $t = 0$ must be zero. However, for proper ($m = n$) or improper ($m > n$) systems it is possible that $y_{zs}(0) \neq 0$. For the circuit shown in Figure 5 (redrawn below, where $R_1 = 300\ \Omega$, $R_2 = 100\ \Omega$, $L = 25$ mH) the ODE

$$\frac{dy}{dt} + 3000\, y(t) = \frac{1}{4}\frac{df}{dt}$$

is proper because $m = n = 1$. Find the value of the zero-state response $y_{zs}(t)$ at $t = 0$ ($y_{zs}(0) \neq 0$!) assuming that $i_L(0) = 0$ A (no stored energy at time $t = 0$) and

$$f(t) = 4\, e^{-1000\, t}$$

for $t \geq 0$.



3. (5 points) Using the value of $y_{zs}(0)$ calculated in part (2) and the input

$$f(t) = 4\, e^{-1000\, t}$$

for $t \geq 0$, find the zero-state response $y_{zs}(t)$ of the circuit shown above for $t \geq 0$.

4. (9 points) Now consider an RC circuit with input $f(t)$ and output $y(t)$ that is described by the differential equation

$$\frac{dy}{dt} + \frac{1}{RC}\, y(t) = \frac{1}{RC}\, f(t).$$

Given that $C = 0.1\ \mu\text{F}$, determine the value of R so that the response of the circuit to a unit step input has a 10% to 90% rise-time of $\ln(9)$ ms.

Problem 4: (25 points)

The switch in Figure 6 has been closed long enough for the voltages and currents to reach steady-state values. At time $t = 0$ the switch is opened. Assume that $V_1 = 2$ V, $V_2 = 4$ V, $L = 50$ H, $C = 1250\ \mu$F, and $R = 40\ \Omega$.

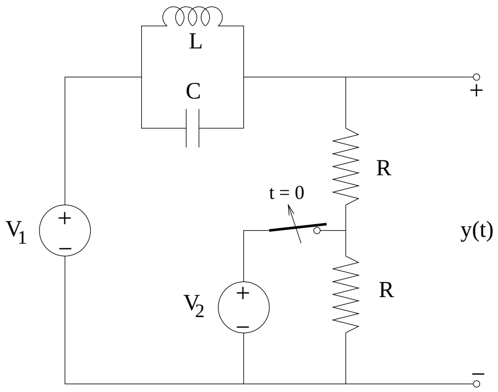


Figure 6: The switch has been closed a very long time before it is opened at time $t = 0$.

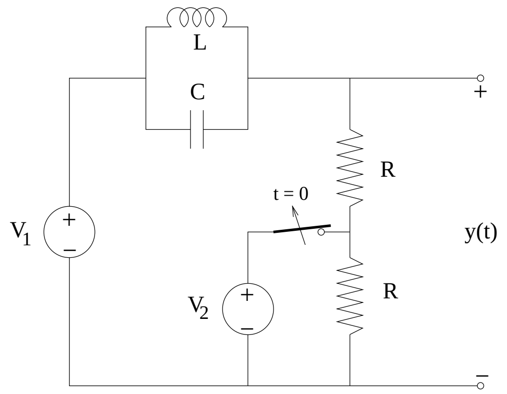
1. (6 points) Find the initial conditions

$$
\begin{aligned}
y(0^+) &= \underline{\qquad}\ \text{V} \\
\left.\frac{dy}{dt}\right|_{t=0+} &= \underline{\qquad}\ \frac{\text{V}}{\text{s}}
\end{aligned}
$$

2. (6 points) Once again consider the circuit shown in Figure 6 (redrawn below) where the switch is opened at $t = 0$ and $V_1 = 2$ V, $V_2 = 4$ V, $L = 50$ H, $C = 1250\ \mu$F, and $R = 40\ \Omega$. Find a second-order ODE of the form

$$\frac{d^2y}{dt^2} + \_\_ \frac{dy}{dt} + \_\_\ y(t) = \_\_$$

that describes the behavior of $y(t)$ for $t \geq 0$.



3. (3 points) Find the forced solution y_ϕ.

4. (5 points) State the form of the natural solution $y_n(t)$. Is the response of the system overdamped, critically damped, or underdamped ? Explain the reasoning behind your answer.

5. (5 points) Determine the output voltage $y(t)$ for $t \geq 0$.