Calculators and computers are not allowed. You must show your work to receive credit.

Problem 1 ________/15
Problem 2 ________/20
Problem 3 ________/35
Problems 4-13 ________/30 (3 points each)

Total ______________
1) **(15 points)** The input-output relationship for the following system can be written as

\[ y(t) * A(t) = x(t) * B(t) \]

Determine \( A(t) \) and \( B(t) \)

![System diagram](image)
2) (20 points) For the following interconnected systems,

i) determine the overall impulse response (the impulse response between input $x(t)$ and output $y(t)$) and

ii) determine if the system is causal.

![System Diagram]

a) $h_1(t) = \delta(t - 2), \ h_2(t) = \delta(t + 1)$

b) $h_1(t) = e^{-(t-2)}u(t - 2), \ h_2(t) = u(t)$
3) (35 points) Consider a linear time invariant system with impulse response given by

\[ h(t) = t^2[u(t+2) - u(t-2)] \]

The input to the system is given by

\[ x(t) = [u(t-1)-u(t-2)] - 2[u(t-3)-u(t-4)] \]

Using \textit{graphical evaluation}, determine the output \( y(t) \). Specifically, you must

- Flip and slide \( h(t) \), \textbf{NOT} \( x(t) \)
- Show graphs displaying both \( h(t-\lambda) \) and \( x(\lambda) \) for each region of interest
- Determine the range of \( t \) for which each part of your solution is valid
- Set up any necessary integrals to compute \( y(t) \). Your integrals must be complete, in that they cannot contain the symbols \( x(\lambda) \) or \( h(t-\lambda) \) but must contain the actual functions.
- Your integrals cannot contain any unit step functions
- \textbf{DO NOT EVALUATE THE INTEGRALS!!}
Multiple Choice Problems (30 points, 3 points each)

4) The impulse response for the LTI system \( y(t) = 2x(t) + \int_{-\infty}^{t-2} e^{-(t-\lambda)} x(\lambda + 2) d\lambda \) is

a) \( h(t) = 2u(t) + e^{-t(2)} u(t+1) \)  
   b) \( h(t) = 2\delta(t) + e^{-t(2)} u(t+1) \)
   
   c) \( h(t) = 2\delta(t) + e^{-t(2)} u(t) \)  
   d) \( h(t) = 2\delta(t) + e^{-t(2)} u(t-2) \)
   
   e) \( h(t) = 2\delta(t) + e^{-t(2)} u(t+2) \)  
   f) none of these

5) The impulse response for the LTI system \( \dot{y}(t) - y(t) = x(t-1) \) is

a) \( h(t) = e^t u(t) \)  
   b) \( h(t) = e^{-t} u(t) \)  
   c) \( h(t) = e^{-(t-1)} u(t) \)
   
   d) \( h(t) = e^{-(t-1)} u(t-1) \)  
   e) \( h(t) = e^{(t-1)} u(t-1) \)  
   f) none of these

6) For a system with input \( x(t) \) and output \( y(t) \), is it necessary for \( y(t_0) = 0 \) in order for the system to be linear?

a) Yes  
   b) No

7) For a system with input \( x(t) \) and output \( y(t) \), is it necessary for \( y(t_0) = 0 \) in order for the system to be time-invariant?

a) Yes  
   b) No
Problems 8-11 refer the following graph showing the response of a second order system to a step input.

8) The percent overshoot for this system is best estimated as
   a) 400%  b) 250%  c) 200%  d) 150%  e) 100%  f) 25%

9) The (2%) settling time for this system is best estimated as
   a) 1.5 ms  b) 2.5 ms  c) 4 ms  d) 5 ms

10) The static gain for this system is best estimated as
    a) 1  b) 2  c) 3  d) 4
11) Assume we have a first order system in standard form, and the input is a step. The usual form used to compute the response of the system is

a) \[ y(t) = [y(0) - y(\infty)]e^{-t/\tau} + y(0) \]  
b) \[ y(t) = [y(\infty) - y(0)]e^{-t/\tau} + y(0) \]  
c) \[ y(t) = [y(\infty) - y(0)]e^{-t/\tau} + y(\infty) \]  
d) \[ y(t) = [y(0) - y(\infty)]e^{-t/\tau} + y(\infty) \]

Problems 12 and 13 refer to the following circuit:

12) The Thevenin resistance seen from the ports of the capacitor is

a) \( R_{th} = R_a + R_b \)  
b) \( R_{th} = R_c \)  
c) \( R_{th} = R_c \parallel (R_a + R_b) \)  
d) \( R_{th} = R_a + R_b + R_c \)  
e) none of these

13) The static gain for the system is

a) \( K = 1 \)  
b) \( K = \frac{R_c}{R_a + R_b + R_c} \)  
c) \( K = \frac{R_a + R_b}{R_a + R_b + R_c} \)  
d) \( K = \frac{R_c}{R_a + R_b} \)  
e) none of these
Name _____________________________________________  Mailbox __________________