Name: ________________________________

Instructions:
The examination lasts for 75 minutes and is closed book, closed notes. No electronic devices are permitted, including but not limited to calculators, cellphones, and other handheld devices. (Any such items in the examination room must be off and put away, subject to a 20 point penalty for the first violation and a score of 0 on the exam for the second violation.)

A formula sheet with Laplace transform pairs and Laplace transform properties is provided. Write your name on it and hand it in with your exam. **Do not write anything on this sheet other than your name.** If anything else is written, or if there are erased marks on the sheet, 20 points will be deducted from your grade.

Do all your work on the pages in this exam booklet. **Do not unstaple these pages. Any unstapled or restapled pages will NOT be graded.** Two extra worksheets follow the five problems if you need more space. If you use the extra pages at the back, mark clearly what problem is associated with each piece of work. You may write on the backs of the pages if you need to.

Show your work and clearly indicate your final answers. Neatness and organization in your work is important and will influence your grade.

Each problem is weighted toward the final total as shown below.

**Grades**

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1. **[20 points total]** The signal $x(t) = 3e^{-3t}u(t)$ is the input to a linear, time-invariant system.

   (a) **[15 points]** Find the output $y(t)$ if the system’s transfer function is 
   \[ H(s) = \frac{1}{(s + 4)(s + 5)}. \]

   (b) **[5 points]** Find the output $y(t)$ if the system’s transfer function is 
   \[ H(s) = \frac{e^{-2s}}{(s + 4)(s + 5)}. \]
2. **[20 points]** Solve
\[
\frac{d^2 y(t)}{dt^2} + 6 \frac{dy(t)}{dt} + 8 y(t) = 4 x(t)
\]
to find \( y(t) \) for \( t \geq 0 \) when \( x(t) = 2 u(t) \) for \( t \geq 0 \), \( y(0) = 1 \), and \( \dot{y}(0) = -4 \).
3. [20 points] When the input $x(t) = u(t)$ is applied to a linear, time-invariant system, the output is

$$y(t) = \left[ 3 - 3e^{-4t} \right] u(t).$$

What is the output when $x(t) = t u(t)$?
4. **[20 points]** Draw a block diagram consisting of integrator blocks, multiplier blocks, and summing junctions that implements the transfer function

\[
\frac{Y(s)}{X(s)} = H(s) = \frac{3s^2 + 4s + 7}{s^2 + 4s + 5}.
\]

Make your implementation have the smallest possible number of integrator blocks.
5. [20 points total] A linear time-invariant system has transfer function

\[ H(s) = \frac{s + 2}{s(s + 1)}. \]

(a) Is this system bounded-input, bounded-output stable? State your reasoning.
(b) What is the output \( y(t) \) if the input is \( x(t) = (1 + e^{-2t})u(t) \)?
EXTRA WORKSHEET (indicate problem number clearly)
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