EGR 261 Due date: _____
Signals and Systems (See Due Dates Table)
File: N261H1

Homework Assignment #1 – Laplace Transforms

Reading Assignment:
Ch. 12, Sect. 1-9 in *Electric Circuits, 9th Edition* by Nilsson
Lathi: Chapter 4, Sections 1-3
Lathi: Sections B.5
Handout: Laplace Transform Properties and Common Laplace Transform Pairs
Lecture notes

Notes:
- Avoid using calculators or software to find Laplace Transforms in this assignment since they will not be allowed on the test.
- Use the assigned **Problem Format** specified below (also see web page for an example).

PROBLEM FORMAT:
- Write out **all** given information with the problem, including problem statements, circuits, sketches, etc.,
- Box your final answers
- Include 3 significant digits with all non-integer answers
- Present you work neatly
- Work all problems in pencil (so that you can erase errors)
- Include units with your final answers when appropriate
- Use correct mathematical notation in your solutions

Mastering Engineering: Mastering Engineering is optional for this class.
- Part 1 (problems from Electric Circuits, 9E) can be done either using Mastering Engineering or by solving the problems by hand and turning them in.
- Parts 2 and 3 must be done by hand and turned in.
- The course ID for Fall 2012 is **MEGORDY261F12**
- The assignment ***Introduction to Mastering Engineering*** may be done for extra credit.

Problem Assignment:
1. Work the following problems from Ch. 12 of *Electric Circuits, 9th Edition* by Nilsson:
   1, 3, 17 (parts a, b, c, d only), 19, 20, 21

2. Determine the Laplace transform of each function below using Laplace transform properties:

   a) $(t^2 - 2t + 1)u(t)$ b) $(t + 2)^2u(t-1)$ c) $2t\cos(wt + b)u(t)$ d) $te^{-2t}u(t - 3)$

   e) $3te^{-4t}\cos[2(t - 1)]u(t - 1)$ f) $\int_0^t \frac{\sin(x)}{x}dx$

3. Determine the Laplace transform of $f(t) = 5te^{-6t}u(t)$ using the Laplace transform properties in the following orders (all results should be the same):
   a) modulation before complex differentiation
   b) complex differentiation before modulation

4. Extra Credit: Use MATLAB to find the Laplace transforms in problem 2 above and in problem 12-17 (parts a, b, c, d only). Put all problems in a single MATLAB program with an initial block of comments (name, course assignment number, etc) and add a comment identifying each part. Include a printout of the program and the output. Check your results to make sure that they are correct.

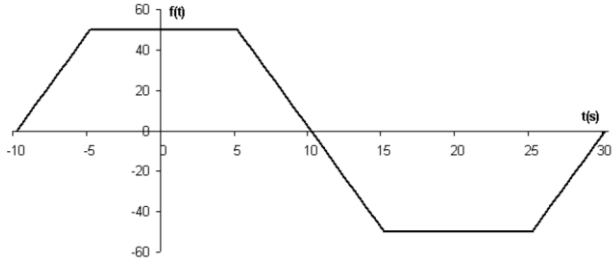
Useful relationships:

$$\int \frac{dx}{x^2 + a^2} = \frac{1}{a}\tan^{-1}\left(\frac{x}{a}\right) \qquad \frac{\pi}{2} - \tan^{-1}(a) = \tan^{-1}\left(\frac{1}{a}\right)$$

$$\cosh(x) = \frac{e^x + e^{-x}}{2} \qquad \sinh(x) = \frac{e^x - e^{-x}}{2} \qquad \cos(A + B) = \cos(B)\cos(A) - \sin(B)\sin(a)$$

Selected Answers:

12.1)



12.19) a) $\frac{40e^{-3s}}{s+8}$

b) $F(s) = \frac{8\left[e^{-s} - 2e^{-2s} + 2e^{-4s} - e^{-5s}\right]}{s^2}$

12.20) a) $\frac{1}{(s+a)^2}$ b) $\frac{s}{(s+a)^2}$ c) $\frac{s}{(s+a)^2}$

12.21) A) $f(t) = 5t\left[u(t) - u(t-2)\right] + (20 - 5t)\left[u(t-2) - u(t-6)\right] + (5t - 40)\left[u(t-6) - u(t-8)\right]$

or $f(t) = 5tu(t) - 10(t-2)u(t-2) + 10(t-6)u(t-6) - 5(t-8)u(t-8)$

so $L\{f(t)\} = \frac{5\left[1 - 2e^{-2s} + 2e^{-6s} - e^{-8s}\right]}{s^2}$

B) Include graph for f'(t) and find an expression for f'(t). Then shown that:

$$L\{f'(t)\} = \frac{5\left[1 - 2e^{-2s} + 2e^{-6s} - e^{-8s}\right]}{s}$$

C) Include graph for f'(t) and find an expression for f'(t). Then shown that:

$$L\{f''(t)\} = 5\left[1 - 2e^{-2s} + 2e^{-6s} - e^{-8s}\right]$$

2) a) $\frac{s^2 - 2s + 2}{s^3}$ b) $\frac{e^{-s}(9s^2 + 6s + 2)}{s^3}$

c) $\frac{2[(s^2 - w^2)\cos(b) - 2 \cdot s \cdot w \cdot \sin(b)]}{(s^2 + w^2)^2}$

d) $\frac{e^{-3(s+2)}(3s+7)}{s^2+4s+4}$ e) $\frac{3e^{-(s+4)}(s^3+13s^2+60s+92)}{(s^2+8s+20)^2}$

f) $\frac{1}{s}\tan^{-1}\left(\frac{1}{s}\right)$

3) A) $F(s)=\frac{5}{(s+6)^2}$ B) $F(s)=\frac{5}{(s+6)^2}$