MECH 221 MATH LEARNING GUIDE — WEEK EIGHT (starts 2014-11-10)

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Lecture Schedule.

2014-11-10 (Mon):	MATH 19, Algebraic Tricks for Inverting the Laplace Transform
2014-11-12 (Wed):	MATH 20, How Laplace Transforms Solve Familiar Problems
2014-11-14 (Fri):	MATH 21, Discontinuous Inputs, Generalized Solutions, and Shift Theorem 2

Overview. This week we continue our work with the Laplace Transform. This tool provides a new way to approach familiar problems, which is already valuable, but then there's more: ideas from the s-domain inspire new ideas and approaches in the time domain.

Learning Goals. You have mastered this week's material when you can ...

1. Use the following methods of "aggressive algebra" to rewrite a given Laplace Transform as a sum of terms that are each easy to invert:
- ☐ add+subtract trick,
- ☐ multiply/divide trick,
- ☐ partial fractions (including cases with repeated real or complex roots).

2. Convert a given piecewise specification of a right-continuous function into a sum of terms involving the Heaviside step function.

3. Convert a given sum of terms involving the Heaviside step function into a piecewise specification for the functioin involved.

4. Find the Laplace Transform of functions like $u(t-a)f(t-a)$. (Use Shift Theorem #2.)

5. Find the inverse Laplace Transform of functions like $e^{-as}F(s)$. (Use Shift Theorem #2.)

6. Solve nonhomogeneous initial-value problems whose forcing functions involve jump discontinuities and/or piecewise-defined functions.

7. Find the Transfer Function of a given differential equation with clearly specified inputs and outputs using Laplace Transforms.

8. Find a given system's steady-state gain and phase shift, as functions of the input frequency, starting from the system's transfer function.

9. Set up a differential equation (and derive the transfer function) for simple dynamical and electrical systems.

10. Solve a vector-matrix IVP like $\dot{\mathbf{x}} = A\mathbf{x} + \mathbf{G}(t)$, $\mathbf{x}(0) = \mathbf{x}_0$ using the Laplace Transform.

Textbook Sections.

- ☐ **JL 6.2 — Transforms of derivatives and ODEs:** Read this whole section. Last week we covered the methods needed to solve problems 6.2.3–6.2.5. Now you should be able to handle all of the exercises listed in Section 6.2.6.
- ☐ **WFT 8.2 — The Inverse Laplace Transform:** Last week's Learning Guide endorsed problems #1–8 in this section. If you got through many of them, congratulations! If not, now is the time to try again.
- ☐ **WFT 8.3 — Solution of Initial Value Problems:** Likewise, for problems #1–37.
- ☐ **WFT 8.4 — The Unit Step Function:** We saw this on Friday, and there will be a little more next week. Practice on some selections from #1–29.

Next Week's Test. On Thursday 20 November 2014, there will be a 110-minute test starting at 08:00. Out of the 75 marks available in total, the number designated for "Math" is 22.5. These come from one 25-mark problem that combines Math with Circuits (12.5 marks each), and two 5-mark problems focussed on Math. Learning goals from weeks Six, Seven, and Eight may be tested.