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 function 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 \( \dot{x} = Ax + G(t) \), \( x(0) = x_0 \) 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.