2.04A Concepts

Linear time invariant systems

Solution in the time domain (ordinary differential equations – ODEs)

Solution in the Laplace domain (transfer function – TF)
- Poles and zeros; their physical meaning
- Stability: stay on the left-hand plane

1st order systems
- Impulse, step, and other responses
- Time constant
- Steady state

2nd order systems
- Impulse, step, and other responses
- Dominant pole (slow/fast poles)
- Over-/critically/under-damped response
- Damping ratio, natural frequency, damped oscillation frequency
- Rise time, settling time, peak time, overshoot
- Steady state

State space: formulation only
- Eigenvalues of system matrix ⇔ system poles

Certain physical implementations
- Flywheel
- DC motor with flywheel load and with/without inductance
- Simple RC / RL / RLC circuits, impedance and voltage divider
- More generally: physical model => ODE => system behavior

Feedback

Feedback loop architecture and feedback transfer function
- Feedback loop terminology: plant, controller, open/closed loop TFs
- The significance of feedback gain and steady-state error

Root Locus (finding the location of closed-loop poles as gain changes)
- Theorems for drawing Root Locus (but not in exhaustive detail, as in the book; what we covered in class only)
- Root Locus concepts and their physical meaning: branches, asymptotes, real and imaginary axis intercepts, break-out/break-in points

Controlling the transient response
- P-control (simplest, limited)
- PD-control (stabilizes and speeds up)
- I-control (terrible but it does fix steady-state error)
- PI-control (fixes steady-state error at cost of slight slowdown)
- PID-control (good compromise of all the above)