EE 141 – Midterm
Fall 2008

11/05/08
Duration: 1 hour and 40 minutes

The midterm is closed book and closed lecture notes. No calculators.
You can use a single page of handwritten notes.
Please carefully justify all your answers.

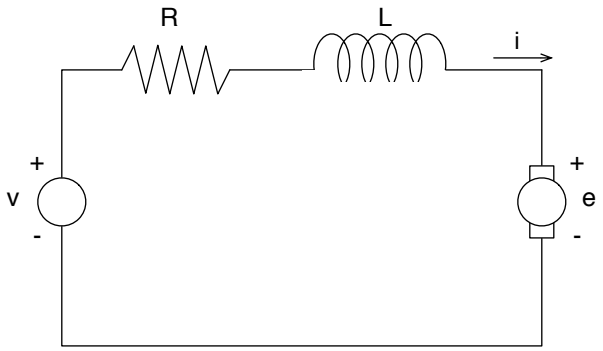

Figure 1: Circuit for Problem 1.

Problem 1: Consider the electric circuit used to drive a DC motor, represented in Figure 1.

1. Write the differential equation governing the voltage on the circuit knowing that the voltage drop across the DC motor is given by $e = K_e \frac{d\theta}{dt}$ where θ is angular position of the motor's axle.

2. Write the differential equation governing θ knowing that: the motor has moment of inertia J, there is a friction torque proportional to the angular velocity with constant of proportionality b, the circuit's current i induces a torque given by $K_t i$.

3. Compute the transfer function from input voltage to the motor's angular position.

4. Assuming that all the coefficients appearing in the transfer function have value 1, that is $K_t = K_e = J = L = R = b = 1$, what is the impulse response of this system?

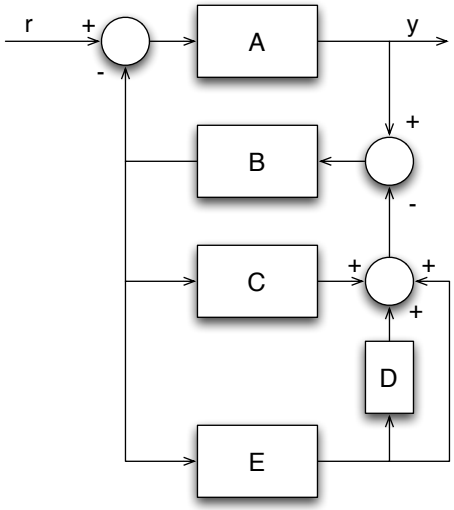

Figure 2: Block diagram for Problem 2.

Problem 2: Consider the system represented in Figure 2 with input r and output y.

1. Compute the transfer function from r to y.
2. Consider the system described by the transfer function:

$$\frac{2s+5}{s^3+(k+20)s^2+10s+20}$$

   For which values of k is this system stable?

Problem 3:

1. Draw a sketch of the root locus for a plant with transfer function:

$$\frac{s+1}{(s-1)(s+2)^2}$$

   in a unit-feedback configuration.

2. Where can you place the slowest pole by choosing different values of K?