Tutorial 5

1. Problem 4.19 (modified): A system has a damping ratio of 0.15, a natural frequency of 20 rad/s, and a DC gain of 1.

- Find the system's transfer function.
- Find the general form of the response to a step input.
- Find the exact expression of the time response to a unit step input.

2. A system with a forward path and a negative feedback of transfer functions $\frac{K_1}{s(s+1)}$ and $(1 + K_2 s)$, respectively, for some scalar gains K_1 and K_2.

- Compute the damping ratio.
- Determine the values of the gains K_1 and K_2 so that the maximum overshoot is 0.2 and the peak time is 1 second.
- Determine the values of the gains K_1 and K_2 so that the damping ratio is 0.7 and the settling time is 4 seconds.
- When $K_1 = 10$, for what value(s) of K_2 is the system over-damped?

3. A negative unity feedback system with a forward path transfer function of $\frac{K_a}{Ks(\tau_m s+1)}$, for some scalar gains K_a, K and time constant τ_m.

- Write down the system's transfer function.
- Assuming that $K = 2$, find the values of K_a and τ_m so that the system has the fastest response to a step input with no overshoot and a settling time of 0.2 seconds.