Practical 6

Tuesday, April 2, 2019 11:00 AM

Topics to be covered

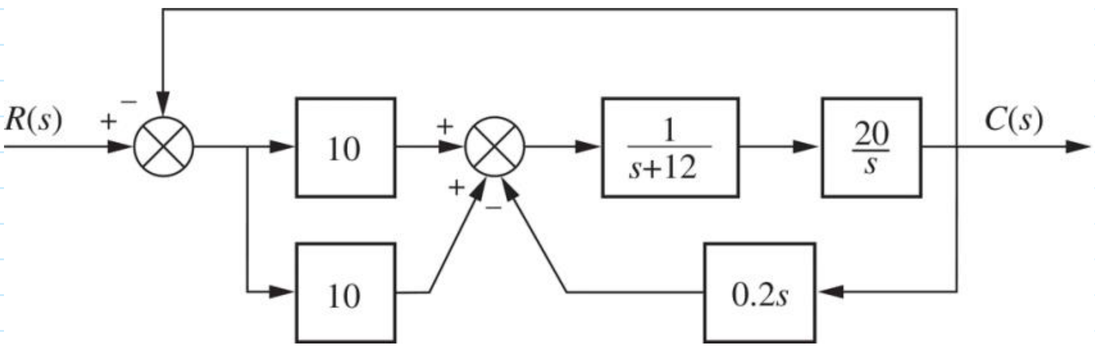
- Reduction of Multiple Subsystems
  a) Block Diagrams
  b) Signal-Flow Graphs
- Stability
  a) Routh-Hurwitz Criterion

Before practical

Problem 1: [Section: 5.3]

Find the following for the system shown in figure below:

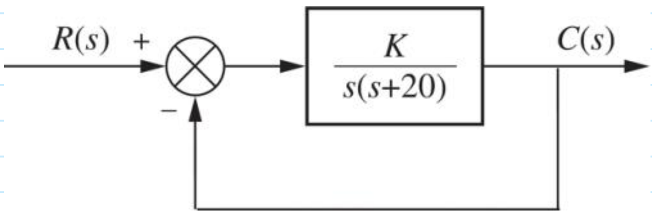
a) The equivalent single block that represents the transfer function, $T(s) = C(s)/R(s)$.
b) The damping ratio (ζ), natural frequency (ω_n), percent overshoot ($\%OS$), settling time (T_s), peak time (T_p), rise time (T_r), and damped frequency of oscillation (ω_d).



Problem 2:

From figure below, find the value of K that will result in 15% overshoot for step inputs.

Note! *This kind of exercise **does not involve** R(s)=1/s, like you would do for finding the time response c(t) by applying Inverse Laplace. The exercise here is to find the closed loop transfer function T(s) of the unity feedback system, then use the general form of second order systems to find K.*



Problem 3: [Sections: 5.2]

a) Draw a signal-flow graph of the system represented in state space below.

$$\begin{bmatrix} \dot{x_1} \\ \dot{x_2} \\ \dot{x_3} \end{bmatrix} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -3 & -5 & -2 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} r$$

$$y = \begin{bmatrix} 1 & 0 & 0 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} + [0]r$$

b) Draw a signal-flow graph of the transfer function $G(s)$ shown below. Note! *First, obtain the state-space representation of the transfer function G(s), then draw the signal-flow graph.*

$$G(s) = \frac{C(s)}{R(s)} = \frac{s^2 - 3s + 5}{s^4 + 2s^2 - 4s + 10}$$

Problem 4: [Sections: 6.3]

Use a Routh array to find out how many poles of the closed-loop transfer function $T(s)$ are in the left half-plane (LHP), right half-plane (RHP), and on the $j\omega$-axis.

$$T(s) = \frac{s - 2}{s^5 - 2s^4 + 4s^3 - 3s^2 + 2s - 3}$$

Problem 5: [Sections: 6.4]

Find the rage of K for closed-loop stability in the unity-feedback system of figure

below if $G(s) = \frac{K(s-1)}{s(s+2)(s+3)}$

Note! *Use Routh array to find K.*