Aerospace Engineering Department, IIT Bombay
AE 308 & AE 775 - Control Theory
Tutorial 3

Q1

Comment whether the response of the given systems subjected to a unit step input is overdamped/underdamped/undamped/critically damped.

1. $\dfrac{25}{s^2 + 12s + 25}$
2. $\dfrac{100}{s^2 + 7s + 100}$
3. $\dfrac{49}{s^2 + 14s + 49}$
4. $\dfrac{121}{s^2 + 121}$
5. $\dfrac{64}{s^2 + 8s + 64}$

Q2

Find the steady-state error due to a ramp input for a type two system.

Q3

The open-loop transfer function of a unity feedback system is given by

$$G(s) = \frac{K}{s(s+1)}$$

If the value of gain K is such that the system is critically damped, find the location of the closed-loop poles of the system.

Q4

The open-loop transfer function of a unity feedback system is given by

$$G(s) = \frac{10}{s+1}$$

Find the steady-state error due to a unit step input signal.

Q5

Consider a system with the following forward path and feedback path transfer functions

$$G(s) = \frac{20}{s^2} \qquad ; \qquad H(s) = (s+5)$$

respectively. For a unit step input, find the steady-state output of the system.

Q6

A system has a damping ratio of 0.5, a natural frequency of 100 rad/s, and a dc gain of 1. Find the response of the system to a unit step input.

Q7

Given the system shown in Figure 1, find J and D to yield 20% overshoot and a settling time of 2 seconds for a step input of torque T(t).

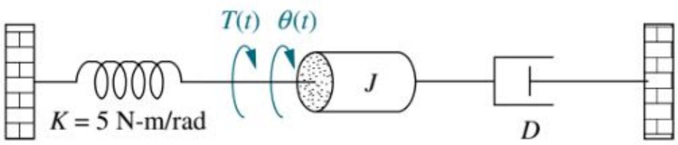

Figure 1: Rotational Mechanical System

Q8

Reduce the system shown in Figure 2 to a single transfer function, $T(s) = C(s)/R(s)$.

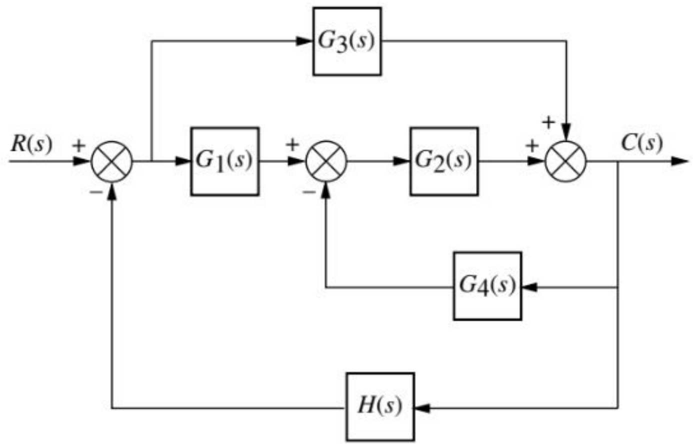

Figure 2: Block diagram

Q9

For the system shown in Figure 3, find the poles and zeros of the closed-loop transfer function, $T(s) = C(s)/R(s)$.

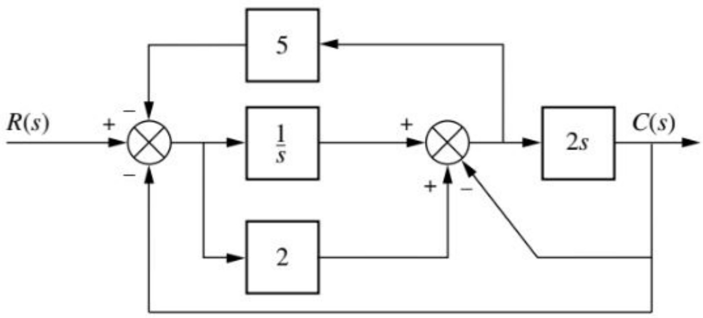

Figure 3: Block diagram

Q10

For each of the following transfer functions, write the general form of the step response:

(1) $G(s) = \dfrac{400}{s^2 + 16s + 400}$ (2) $G(s) = \dfrac{196}{s^2 + 14s + 196}$