Course: EE3004 – Control Engineering Section: **ESB 350**

Semester: July - November 2018

Instructor: Dr. Puduru Viswanadha Reddy Date: 10 September 2018

Quiz - 1 (20 marks)

1. The differential equation corresponding to an LTI system is given by

$$\frac{d^2c(t)}{dt^2} + 3\frac{dc(t)}{dt} + 2c(t) = \frac{dr(t)}{dt} + r(t)$$

We assume zero initial conditions for $c(t)$ and $r(t)$.

a) Find the corresponding transfer function $\frac{C(s)}{R(s)}$. (**1 mark**)

b) Assuming the input to be a unit parabola, i.e., $r(t) = \frac{t^2}{2}u(t)$, find the output $c(t)$? (**2 marks**)

2. (a) Find the transfer function $\frac{C(s)}{R(s)}$ for the system represented in figure below using Mason's gain formula. (**4 marks**)

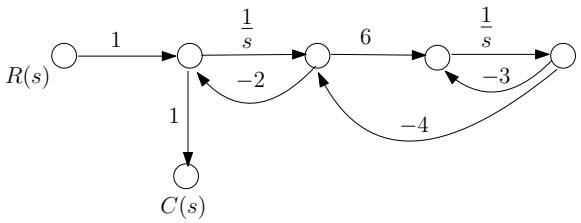


Figure 1: Signal flow graph

(b) Provide a state space representation of the system from the signal flow graph. (**2 marks**).

3. A system is represented in state space form using set of the matrices $(A_{n\times n}, B_{n\times 1}, C_{1\times n}, D_{1\times 1})$. Show that the set of by matrices $(J^{-1}AJ, J^{-1}B, CJ, D)$ also represents the same system. Here $J_{n\times n}$ is an invertible matrix. (**3 marks**)

4. The unit step response to a second order closed-loop system with feedback gain equal to K is shown in the Figure 2(b). Find

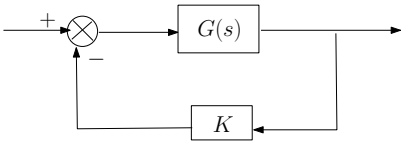
a) Damping ratio - ξ (**1 mark**)

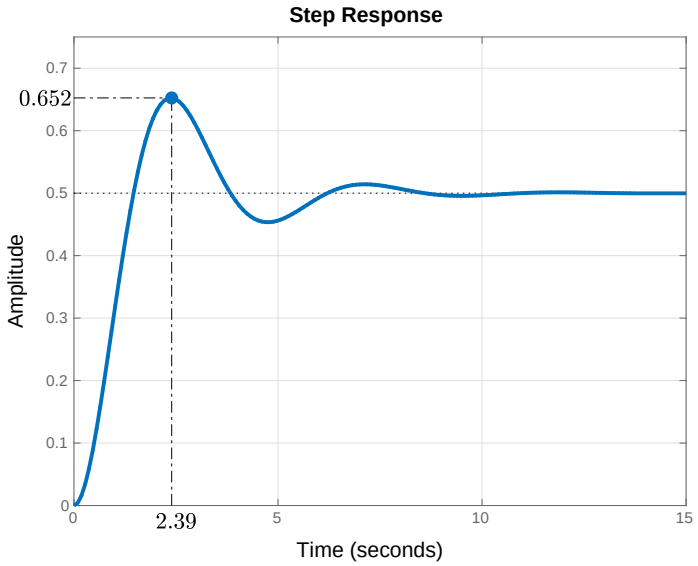
b) Natural frequency - ω_n (**1 mark**)

c) Feedback gain - K and open loop transfer function $G(s)$ (**3 marks**)

d) Response value for the first undershoot (**2 marks**)

e) Time at which second overshoot occurs (**1 mark**)





(a) (b)

Figure 2: Step response of a second order closed-loop system