

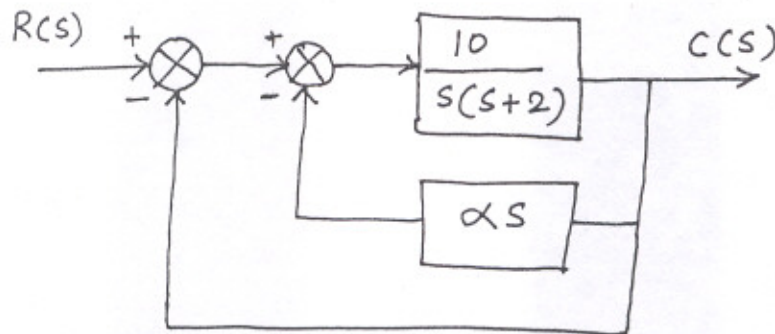
Birla Institute of Technology and Science Pilani  
First Semester 2007-2008  
AAOC C321: Control Systems

B

Quiz 3

Date: 04-10-2007	Duration: 15 Min	MM: 10
Name:	ID No.:	Sec.:

Q. For the control system whose block diagram is given below, determine the value of  $\alpha$  so that step response has a peak overshoot of 10 %. Determine the settling time (for 5% tolerance band) for this value of  $\alpha$  and steady state error for this value of  $\alpha$  if unit ramp input is applied ?



$$\frac{C(s)}{R(s)} = \frac{10}{s^2 + 2s + 10\alpha s + 10} \quad (1)$$

$$\text{As } e^{-\pi \eta / \sqrt{1-\eta^2}} = 0.1 \text{ (Given)} \Rightarrow \frac{\pi \eta}{\sqrt{1-\eta^2}} = 2.3026 \Rightarrow \eta = 0.591$$

$$\text{From (1) } \omega_n = \sqrt{10} \text{ rad/sec} \quad \& \quad 2 + 10\alpha = 2\eta\omega_n = 2 \times 0.591 \times \sqrt{10} \\ \Rightarrow \alpha = 0.174 \text{ (7m)}$$

$$\text{Open loop transfer function} = \frac{10}{s(s+2+10\alpha)}$$

$$\text{So } K_v = \frac{10}{10\alpha + 2} \quad \text{So } e_{ss} = \frac{2 + 1.74}{10} = 0.374 \text{ unit} \quad (1)$$

$$\text{Settling time (5% tolerance band)} = \frac{3}{\eta\omega_n} = 1.604 \text{ sec} \quad (2)$$