Department of Electrical Engineering

College of Engineering Pune

End Semester Exam. Nov 2013

F.Y. M. Tech (Control System) and B. Tech(Elect.)

Digital Control systems (CS 505)

Time Duration 3Hrs. Max. Marks (60)

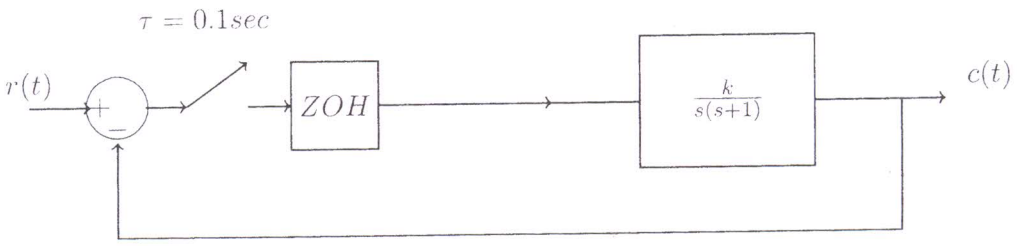
Instructions: Solve all questions. All questions carry equal marks. Assume suitable data if needed.

(Q.1a): Determine pulse transfer function of a DC motor which has transfer function $G(s) = \frac{1}{s^2+1.6s+1}$ controlled digitally with the sampling rate as 10 samples per seconds via unity feedback. Analyze open-loop and closed-loop stability.

(Q.1b): Obtain discrete state space representation of the system in (Q.1a).

(Q.1c): If a region in s-plane is bounded by constant zeta lines($\zeta = 0.5$), constant omega lines ($\omega = 7rad/sec$). Map this region in Z-plane.

(Q.2a): Investigate stability of the following system using Jury test.



(Q.2b): Describe the effect of sampling frequency on the system controllability and observability.

Q.(3a): Given the system

$$\mathbf{x}(k+1) = \begin{pmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ a & b & -a/b \end{pmatrix} \mathbf{x}(k) + \begin{pmatrix} 0 \\ 1 \\ 0 \end{pmatrix} u(k)$$

Under what condition the above system is controllable?

Q.(3b): Illustrate reconstructibility and observability of the discrete time system.

Q.(4a): Design a state feedback controller to place the closed-loop poles of the system below at $z = 0.25 \pm 0.25j$:

$$\mathbf{x}(k+1) = \begin{pmatrix} 0 & 1 \\ -0.5 & 1 \end{pmatrix} \mathbf{x}(k) + \begin{pmatrix} 0 \\ 1 \end{pmatrix} \mathbf{u}(k) \; and \; y(k) = \begin{pmatrix} 0.5 & 0 \end{pmatrix} \mathbf{x}(k)$$

Q.(4b): Design a state estimator for the system in $Q.(4a)$.

Q.(5a): Illustrate FOS scheme for design of discrete output feedback control for the plant given below:

$$\dot{\mathbf{x}} = \begin{pmatrix} 0 & 1 \\ -2 & -3 \end{pmatrix} \mathbf{x} + \begin{pmatrix} 0 \\ 1 \end{pmatrix} u \quad y = \begin{pmatrix} 0 & 1 \end{pmatrix}$$

Q.(5b): Design POF controller for the system in Q.(5a).