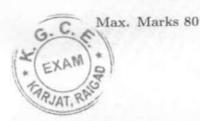
## Paper / Subject Code: 42755 / Digital Control System (DLOC-III)

.E.(Instrumentation Engineering)(SEM-VII)(Choice Base) / Nov 2019 / 22.11.2019

Duration: 3 Hours



## N.B.

- Q.1 is compulsory. Attempt any three from the remaining questions.
- 2. All questions carry equal marks.
- 3. Figures to the Right indicate full marks.
- 3. Assume suitable data if necessary
- Q.1 Attempt any four

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- a. Explain block diagram of digital control system and show all the signal forms in it.
- b. What are the limiting factors that may affect choice of sampling rate for a given system?
- c. What will be the output of first order hold when an impulse at t = 1 is passed through it?
- d. Derive expression for pulse transfer function matrix for a given system represented by state space model.
- Explain use of bilinear transformation in stability analysis of discrete time systems.
- f. What is principle of duality by Kalman?
- Q.2 A. Derive transfer function of Zero order hold and explain its frequency response. 10
  - B. Discretize the given system using Zero order hold with transfer function

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$$G(s) = \frac{5}{s(s+5)}$$

Assume sampling period T=0.1 sec.

Q.3 A. Obtain state transition matrix using Cayley Hamilton theorm for the system described by:

$$x(k+1) = \begin{bmatrix} 0 & 1 \\ -10 & -7 \end{bmatrix} x(k)$$

B. What is meant by completely controllable and completely observable systems? 10 Check controllability of the following discrete time system:

$$x(k+1) = \begin{bmatrix} 0 & 0 & 0 \\ 0 & 0.5 & 0 \\ 0 & 0 & 2 \end{bmatrix} x(k) + \begin{bmatrix} 1 \\ 0 \\ 1 \end{bmatrix} u(k)$$

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Q.4 A. Explain digital PID controller in detail.

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B. The discrete time control system is given by

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$$x(k+1) = \begin{bmatrix} 0 & 1 \\ 20.6 & 0 \end{bmatrix} x(k) + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u(k)$$
$$y(k) = \begin{bmatrix} 1 & 0 \end{bmatrix} x(k)$$

Design a full order observer such that the response to observation error is deadbeat.

Q.5 A Obtain the discrete time state model of the following continuous time system with sampling time of 1 sec:

$$\dot{x}(t) = \begin{bmatrix} 0 & 0 & -0.25 \\ 1 & 0 & 0 \\ 0 & 1 & 0.5 \end{bmatrix} x(t) + \begin{bmatrix} 1 \\ 0 \\ 1 \end{bmatrix} u(t) 
y(t) = \begin{bmatrix} 1 & 0 & 0 \end{bmatrix} x(t)$$

B. Using Jury's stability criteria determine the range of K for asymptotic stability of the system given by characteristic equation

$$P(z) = z^3 + 0.5z^2 + Kz - K = 0$$

Q.6 A. Determine steady state error for unit step, ramp and acceleration inputs for a unity feedback system characterized by transfer function:

$$G_{ho}G(z) = \frac{1.266z + 0.5702}{z^2 - 1.082z + 0.08208}$$

B. Determine state feedback gain matrix K for the system given by :

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$$x(k+1) = \begin{bmatrix} 1 & 0.2 \\ 0 & 1 \end{bmatrix} x(k) + \begin{bmatrix} 0.02 \\ 0.2 \end{bmatrix} u(k)$$
$$y(k) = \begin{bmatrix} 1 & 0 \end{bmatrix} x(k)$$

Place closed loop poles at  $0.5 \pm 0.5j$ .