Seat No.: ________ *Enrolment No.*___________

GUJARAT TECHNOLOGICAL UNIVERSITY

M. E. - SEMESTER – I • EXAMINATION – WINTER • 2014

Subject code: 2714702 **Date: 12-01-2015**

Subject Name: Advance Control Systems

Time: 02:30 pm - 05:00 pm **Total Marks: 70**

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**

Q.1 **(a)** Consider the unity feedback system with **07**

$$G(s) = \frac{k}{s(s+2)}$$

It is desired to design a cascade lead compensator such that the dominant closed loop poles provide a damping ratio=0.5 and undamped natural frequency=4 rad/sec.

(b) Design a PI controller to drive the step response error to zero for the unity feedback system with **07**

$$G(s) = \frac{k}{(s+3)(s+1)(s+10)}$$

The system is operating with a damping ratio of 0.5.

Q.2 **(a)** Consider a plant with transfer function **07**

$$G(s) = \frac{4}{s(s+0.5)}$$

Design a lag-lead compensator to meet the following specification.
Damping ratio=0.5
Undamped Natural frequency=5 rad/sec
Velocity error constant=80 sec^{-1}.

(b) Consider a plant with transfer function **07**

$$G(s) = \frac{k}{s(s+2)}$$

So that the closed loop system has
Phase margin Ó60^0 and Kv Ó10.
Design a suitable lead compensator using frequency response method.

OR

(b) Consider a type-I unity feedback system with an open loop transfer function **07**

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

It is desired to have velocity error constant Kv=10 and Phase margin of the system be at least be 45^0.
Design a suitable lag compensator using frequency response method.

Q.3 **(a)** Consider a unity-feedback system with an open loop transfer function is **07**

$$G(s) = \frac{k}{s(1+0.1s)(1+0.2s)}$$

The system is to be compensated to meet the following specification.
1.velocity error constant Kv=30
2.Phase margin Ó50^0
3.Bandwidth Wb=12 rad/sec.
Design a suitable lag-lead compensator using frequency response method.

(b) Apply cascade decomposition method to obtain state space representation of the transfer function given below: **07**

$$G(s)= \frac{5}{(s+1)^2(s+2)}.$$

OR

Q.3 **(a)** Derive the expression for the solution of state equation using Laplace transform techniques and state properties of state transition matrix. **07**

(b) Derive the transfer function corresponding to the following state model. **07**

$$\begin{bmatrix} \dot{x} \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix} x + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u \text{ ;y=[1 0]x.}$$

Q.4 **(a)** Derive the expression for the controllability test matrix for the state space. **07**

(b) Determine the controllability and observability properties of the system. **07**

$$A= \begin{bmatrix} -2 & 1 \\ 1 & -2 \end{bmatrix}, b=\begin{bmatrix} 1 \\ 0 \end{bmatrix}, c=[1\ -1]$$

OR

Q.4 **(a)** Explain the block diagram of the sampled data control system. **07**

(b) Explain the Juryôs stability test for the discrete time system. **07**

Q.5 **(a)** Find the z-transform of the following: **07**

1.f(t)= cos wt 2.f(t)= $e^{-at}\sin wt$

(b) Explain the stability analysis of the sampled data control system using transformation mapping theorem. **07**

OR

Q.5 **(a)** Discuss the common nonlinearities in control system. **07**

(b) Derive the describing function for the dead zone nonlinearity. **07**

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