Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

ME- SEMESTER II– EXAMINATION – SUMMER 2015

Subject Code: 2720301 **Date: 28/05/2015**

Subject Name: DIGITAL CONTROL

Time: 2:30 PM – 5:00 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)** Realize and discuss the Antiwind up control (AWC) for the 2-DOF pole placement controller design framework **07**

(b) Discuss about j-step ahead prediction error model through noise splitting for ARMAX model. **07**

Q.2 **(a)** Derive GPC law for ARIX model. **07**

(b) Give explanation with necessary derivation for state feedback pole placement control law when system is not in Canonical form. **07**

OR

(b) Give explanation with necessary derivation for state feedback pole placement control law when all system states are not measurable. **07**

Q.3 **(a)** Design compensator for the system given below. Use estimator design approach. Desired characteristic polynomial roots are 0.25±j0.6614. **07**

$$A = \begin{bmatrix} 1 & 2 \\ 0 & 3 \end{bmatrix}, B = \begin{bmatrix} 0 \\ 1 \end{bmatrix}, c = \begin{bmatrix} 1 \\ 0 \end{bmatrix}^{*}$$

(b) Realize discrete PID controller which has incremental formulation of control action. What is the useful property of such kind of realization? **07**

OR

Q.3 **(a)** Design state feedback control law for system given below **07**

$$X(k+1) = \begin{bmatrix} -1 & -2 & -4 \\ 1 & 0 & 0 \\ 0 & 1 & 0 \end{bmatrix} X(k) + \begin{bmatrix} 1 \\ 0 \\ 0 \end{bmatrix} U(k)$$

Desired characteristic polynomial is $Z^3 + Z^2 + \frac{1}{2}Z$

For achieving fastest response with such control law for system having system matrix of size 3x3, how many sample time it takes? Justify with necessary derivations.

(b) Determine the discrete PID controller which has incremental formulation of control action, if the following continuous time PID settings are given. K=2, Td=2.5 sec, Ti=40 sec and Ts=1sec. **07**

Q.4 **(a)** Discuss about the formulation and solution of optimal control problem **07**

(b) Find the minimum variance control for the system given below **07**

$y(n) = \frac{1-a}{1-az^{-1}} u(n-1) + \frac{1}{1-cz^{-1}} \gamma(n)$, where a=0.5, c=0.9 and $\gamma(n)$ is white noise.

OR

Q.4 **(a)** With necessary derivations, discuss about Infinite horizon solution to LQR Design. **07**

(b) Design the minimum variance control law for a system given by ARMAX model with **07**

$A(Z) = (1 - Z^{-1})(1 - 0.7Z^{-1}), B(Z) = (0.9 + Z^{-1}),$
$C(Z) = (1 - 0.7Z^{-1}), K = 1$

Q.5 **(a)** Design a pole placement controller that places the poles of the plant $G(Z) = \frac{Z^{-1}(1+0.9Z^{-1})(1-0.8Z^{-1})}{(1-Z^{-1})(1-0.5Z^{-1})}$, so as to give rise to a closed loop characteristic polynomial $1 - z^{-1} + 0.5z^{-2}$ and to have non zero offset to step inputs. **07**

(b) Design an discrete time IMC for the continuous transfer function of system $G(S) = \frac{1}{(10S+1)(25S+1)}$, Sampled with Ts=3. **07**

OR

Q.5 **(a)** Give the design steps of 2-DOF pole placement controller which ensures the stable controller, robustness and internal stability (in terms of control effort) with reasons and its solutions. **07**

(b) The discrete time model of a system is given by $y(n) = \frac{0.63\,Z^{-3}}{1-0.37\,Z^{-1}}u(n)$. Desired closed loop characteristic polynomial is $(1 - 0.5Z^{-1})$. Compare the performance of a 2-DOF pole placement controller, with and minimum possible value of delay. **07**

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