(3 pages)

# APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FIRST SEMESTER M.TECH DEGREE EXAMINATION, DECEMBER 2015

**Electrical & Electronics Engineering**

(Control Systems, Guidance & Navigational Control, Electrical Machines, Power Systems & Control, Power Control & Drives)

## 01EE6101: DYNAMICS OF LINEAR SYSTEMS

Time: 3Hours Max.Marks:60





*Answer any two questions from each Part*

### Part A (Modules I & II)

1. a) Explain how a lead compensator network can be realised using active electrical components. 3

   b) Apply Ziegler-Nichol's tuning method for determination of parameters $K_p$, $T_i$ and $T_d$ of a PID controller to be used for a plant with open loop transfer function given by $G(s) = \dfrac{1}{s(s+1)(s+2)(s+3)}$ 6

2. a) Explain the different performance measures with description of the relevance of each in Engineering problems. 3

   b) Design suitable compensator for a unity feedback system with open loop transfer function, $G(s) = \dfrac{4}{s(s+0.5)}$ so as to satisfy the following specifications. Velocity error constant, $K_v > 80/sec^2$, damping ratio=0.5, undamped natural frequency of oscillations=5 rad/sec 6

3. a) Explain in detail how proportional, integral and derivative gains influence the performance of a system. 3

b) The forward transfer function of a unity feedback system is given as $G(s) = \dfrac{K}{s(s+3)(s+6)}$. Design a lag-lead compensator so that the system satisfies the following specifications. Phase margin ≥ 35°, Velocity error constant, $K_v > 80/sec^2$. using Bode plots. 6

**Part B (Modules III & IV)**

4\. a) What are controllability, observability grammians? Explain their significance. 4

b) Derive Ackermann's formula for the determination of feedback gain. 5

5\. a) Explain with suitable examples, how pole cancellation in a system influences its stability.  3

b) A single input system is described by the following state equation

$$\dot{X} = \begin{bmatrix} 1 & 1 & 0 \\ 0 & -1 & 1 \\ 13 & -1 & -2 \end{bmatrix} X + \begin{bmatrix} 2 \\ -1 \\ -2 \end{bmatrix} u \text{ and } y = \begin{bmatrix} 1 & 1 & 0 \end{bmatrix} X$$

Design a full state feedback controller so that the unstable pole shifts to s= -3 in closed loop. Draw the complete state block diagram of the system. 6

6\. Write in brief:

(i) Stabilisability

(ii) Observability and constructability

(iii) Mayne-Murdoch formula

(iv) Non controllable realizations 9

**Part C (Modules V & VI)**

7\. a) Explain direct analysis of Diophantine equation. 5

b) Draw the block diagram of the combined observer controller for the system and hence derive the state representation and transfer function for the same. 7

8\. a) For an undamped harmonic oscillator driven by disturbance input w of unit intensity, $\dot{X} = \begin{bmatrix} 0 & 1 \\ -w_o^2 & 0 \end{bmatrix} X + \begin{bmatrix} 0 \\ 1 \end{bmatrix} w$. Determine the locus of optimum modes for an observer that uses a noisy measurement $y = x_2 + v$, where v is the observation noise of intensity r. 5

b) A regulator system has the plant $\dot{X} = \begin{bmatrix} 0 & 20.6 \\ 1 & 0 \end{bmatrix} X + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u$, $y = \begin{bmatrix} 0 & 1 \end{bmatrix} X$., The closed loop poles are to be placed at $s = -2 \pm j2\sqrt{3}$. Design a controller and observer so that the observer error poles are placed at $s = -1.8 \pm j2.4$. Draw the complete state block diagram. 7

9. a) What is meant by separation principle with regard to observer design? Explain. 4

b) Convert the following system into controllable companion form

$$\dot{X} = \begin{bmatrix} 0 & 0 & -3 \\ 2 & 0 & -7 \\ 0 & -1 & 0 \end{bmatrix} X + \begin{bmatrix} 1 & 1 \\ 0 & -1 \\ 0 & 1 \end{bmatrix} u$$

Obtain the transformed pair (A, B) in all possible ways. 8