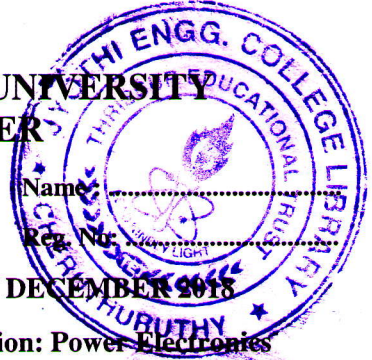


M.Tech SI

APJ ABDULKALAM TECHNOLOGICAL UNIVERSITY
08 PALAKKAD CLUSTER



08PE22118

(Pages: 3)

FIRST SEMESTER M.TECH. DEGREE EXAMINATION DECEMBER 2018

Branch: Electrical Engineering

Specialization: Power Electronics

08EE 6221 System Dynamics

Time: 3 hours

Max. marks: 60

Answer all six questions.

Modules 1 to 6: Part 'a' of each question is compulsory and answer either part 'b' or part 'c' of each question.

Q.no.	Module 1	Marks
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1.a	Derive an expression for the sensitivity of eigen values with respect to parameters of the system matrix.	3
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Answer b or c

b	Consider the system defined by $\dot{x} = \begin{bmatrix} a & b \\ 0 & d \end{bmatrix} x$. Obtain state model in the decoupled form. Find the participation of modes in states and sates in modes.	6
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c	Obtain the solution of the state equation,	6
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$$\dot{x} = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix} x, \text{ to the initial condition } x(0) = [2 \ 3]^T$$

Q.no.	Module 2	Marks
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2.a	Explain a procedure to obtain a discrete time state equation of a continuous system at sampling instants.	3
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Answer b or c

b	Consider the system defined as $\frac{Y(z)}{U(z)} = \frac{z+1}{z^2+1.3z+0.4}$. Obtain state space representations in (i) controllable and (ii) observable canonical forms.	6
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- c Obtain the state transition matrix $x[k]$, and $y[k]$ of the discrete system with $x[k+1] = Gx[k] + Hu[k]$; $y[k] = Cx[k]$ where $G = \begin{bmatrix} 0 & 1 \\ -0.16 & -1 \end{bmatrix}$, $H = \begin{bmatrix} 1 \\ 1 \end{bmatrix}$, $C = [1 \ 0]$. $u[k]$ is the unit step input and $x[0] = \begin{bmatrix} 1 \\ -1 \end{bmatrix}$. 6

Q.no. **Module 3** **Marks**

- 3.a Explain Lyapunov's general stability definitions as applied to a system. 3

Answer b or c

- b Discuss the stability of the system, $x[k+1] = \begin{bmatrix} 0 & 1 \\ -0.5 & -1 \end{bmatrix}x[k]$. Use Liapunov's method. 6

- c Explain the application of Krasovski's theorem for stability analysis. Analyse the stability of the system using the same. 6

$$\dot{x}_1 = -x_1$$

$$\dot{x}_2 = x_1 - x_2 - x_2^3$$

Q.no. **Module 4** **Marks**

- 4.a Write the state space representation of a linear continuous time system. Discuss the state controllability of the system. Then obtain an observable state model, applying duality principle. 3

Answer b or c

- b Discuss the state controllability of the following system 6

$$\dot{x} = \begin{bmatrix} -3 & 1 \\ -2 & 1.5 \end{bmatrix}x + \begin{bmatrix} 1 \\ 4 \end{bmatrix}u. \text{ Justify your result.}$$

- c Explain an observable state model. State and prove the condition for observability of a continuous time linear time invariant system. 6

Q.no. **Module 5** **Marks**

- 5.a Discuss the effect of state feedback on controllability. 4

Answer b or c

- b Explain the process of observer design. Consider the system defined by $\ddot{y} = u$. Design a state observer such that the eigen values of observer gain matrix are at $-2 \pm j2\sqrt{3}$. 8

- c Consider a system defined by $x[k+1] = \begin{bmatrix} 0 & 1 \\ -0.16 & -1 \end{bmatrix} x[k] + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u(k)$. 8
Determine a suitable state feedback gain matrix K such that the system will have the closed loop poles at $0.5 \pm j0.5$. Verify by Ackerman's method also.

Q.no.	Module 6	Marks
6.a	Explain optimal control of (i) state regulator problem and (ii) tracking problem.	4

Answer b or c

- b A continuous system is described by $\dot{x} = \begin{bmatrix} 0 & 1 \\ 0 & 0 \end{bmatrix} x + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u$. Assume the linear control law $u = -Kx$. Determine K so that the following performance index $J = \int_0^{\infty} x^T x dt$ is minimised. 8

- c (i) Explain the use of Liapunov's second method for the solution of parameter optimization problem. 8

(ii) Consider the system $\dot{x} = \begin{bmatrix} 0 & 1 \\ -1 & -2\xi \end{bmatrix} x$, $x[0] = \begin{bmatrix} 1 \\ 0 \end{bmatrix}$. Determine the value of $\xi > 0$, so that when the system is subjected to a unit step input $r(t)$, the following performance index is minimised $J = \int_0^{\infty} x^T Q x dt$,

$$Q = \begin{bmatrix} 1 & 0 \\ 0 & \mu \end{bmatrix}, \mu > 0.$$