BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI
(END SEMESTER EXAMINATION)

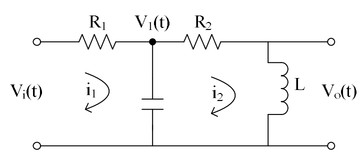
CLASS: M.TECH **SEMESTER : I**
BRANCH: EEE **SESSION : MO/18**

SUBJECT: EE503 MODERN CONTROL THEORY
TIME: 3.00 HOURS **FULL MARKS: 50**

INSTRUCTIONS:
1. The question paper contains 5 questions each of 10 marks and total 50 marks.
2. Attempt all questions.
3. The missing data, if any, may be assumed suitably.
4. Before attempting the question paper, be sure that you have got the correct question paper.
5. Tables/Data hand book/Graph paper etc. to be supplied to the candidates in the examination hall.

Q.1(a) State the physical significance of eigenvalues. Find the eigenvalues and eigenvectors of the matrix A given by $A = \begin{bmatrix} 1 & -1 \\ 0 & -1 \end{bmatrix}$ [5]

Q.1(b) Develop equations and build the signal flow graph and solve for transfer function $\frac{V_O(s)}{V_i(s)}$ using Mason's gain formula. [5]



Q.2(a) Analyze Cayley- Hamilton method for A= $\begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix}$.Manipulate A^{-1}, A^2. [4]

Q.2(b) The transfer function of a system is given as $\frac{Y(s)}{U(s)} = \frac{2s^2+s+5}{s^3+6s^2+11s+4}$.Design state model and state diagram in the canonical forms (i) CCF and (ii) OCF. [6]

Q.3(a) Illustrate linearization of nonlinear model. Defend its importance in control theory. Linearize the equation $z = x^2 + 4xy + 6y^2$ in the region defined by $8 \le x \le 10$ and $2 \le y \le 4$ [5]

Q.3(b) Construct a Liapunov function and determine the type of stability for the following system. [5]

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} 0 & 2 \\ -2 & -1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$

Q.4(a) Express controllability and observability. A control system is described by the differential equation $\frac{d^3y(t)}{dt^3} = u(t)$. Check the controllability and observability of the system. [5]

Q.4(b) State principle of duality “Controllability of pair $[A \quad B]$ implies the observability of pair $[A^T \quad B^T]$” - Justify. [5]

Q.5(a) Compare regulation with tracking. Construct the block diagram of system and full-order observer, when input and output are scalars. [4]

Q.5(b) Estimate a regulator system for the following plant, where$A = \begin{bmatrix} 0 & 1 \\ 20.6 & 0 \end{bmatrix}$, $B = \begin{bmatrix} 0 \\ 1 \end{bmatrix}$, $C = \begin{bmatrix} 1 & 0 \end{bmatrix}$. By using state feedback control law $u = -kx$ design the state feedback gain matrix k if it is desired to have the closed loop poles at $s = -1.8 \pm j2.4$. Further design the observer gain matrix k_e if it is desired to have the both the observer poles at $s = -8$ by using observed state feedback control$u = -k\tilde{x}$. [6]

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