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

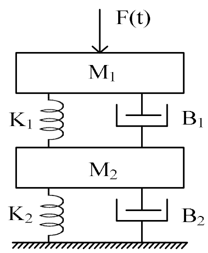
CLASS: MTECH — **SEMESTER : I**
BRANCH: EEE — **SESSION : MO/19**

SUBJECT: EE503 MODERN CONTROL THEORY

TIME: 3 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) Outline the concept of modeling. Consider the mass-spring damper system consisting of two platforms coupled to each other and to a fixed support via springs and dashpot dampers. (a) Select a set of state variables, (b) Write the matrix differential equation and specify the elements of the matrices. Obtain the state-space representations. [5]



Q.1(b) State and test Cayley- Hamilton method for A= $\begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix}$.Manipulate A^{-1}, A^2. [5]

Q.2(a) Outline the concept of eigenvalues and eigenvectors. Find the eigenvalues and eigenvectors of the matrix A given by $A = \begin{bmatrix} 1 & 3 \\ -6 & -5 \end{bmatrix}$. [5]

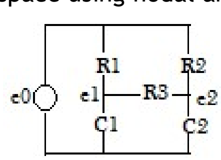
Q.2(b) Outline the concept of decompositions of transfer functions. [5]
The transfer function of a system is given as $\frac{Y(s)}{U(s)} = \frac{2s^2+s+5}{s^3-6s^2+11s+4}$.Design state model and state diagram in the CCF canonical form.

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 $2 \le y \le 4$ and analyze the percentage error when evaluated at the range boundary. [5]

Q.3(b) Estimate the solution of an nth order homogeneous and non-homogeneous state equation. A linear time-invariant system is characterized by the non-homogeneous state equation [5]
$\dot{X} = \begin{bmatrix} 0 & 1 \\ -6 & -5 \end{bmatrix} X + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u$. Assess the non-homogeneous solution if the initial state is $X(0) = \begin{bmatrix} 1 \\ 0 \end{bmatrix}$ and u is a unit step function.

Q.4(a) Discuss input-output controllability and observability. "Controllability of pair $[A \quad B]$ implies the observability of pair $[A^T \quad B^T]$" - Justify. [5]

Q.4(b) Represent the electrical network in state space using nodal analysis, e_0, e_1 and e_2 are the voltages. [5]



Check the controllability of the network.

PTO

Q.5(a) What is state observer? Plan the steps to summarize the state-space design method based on pole-placement combined with observer approach. [5]

Q.5(b) Consider the system represented in state variable form $\dot{X} = AX + BU$ and $Y = CX$, where $A = \begin{bmatrix} 0 & 4 \\ -5 & 10 \end{bmatrix}$, $B = \begin{bmatrix} 0 \\ 1 \end{bmatrix}$, $C = \begin{bmatrix} 1 & -4 \end{bmatrix}$. Verify that the system is observable. Then design a full-state observer by placing the observer poles at $s_{1,2}$=-1. [5]

:::::02/12/2019:::::E