[This question paper contains 3 printed pages.]

Your Roll No. .....

3218 **J**

MEE

Paper—EE.651

OPTIMAL CONTROL THEORY

Time : 3 *Hours* *Maximum Marks* : 100

(Write your Roll No. on the top immediately on receipt of this question paper.)

Attempt any ***five*** *questions.*

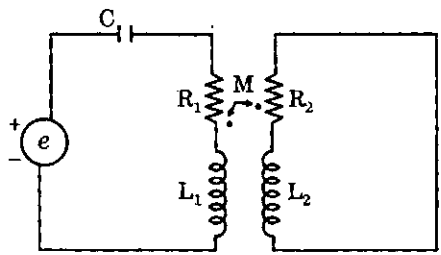
All *questions carry equal marks.*

Assume missing data, if any.

1. (a) Draw a block diagram or signal flow graph and write state and output equation of the transfer function :

$$\frac{Y(s)}{U(s)} = \frac{10[S^3 + 2S + 3]}{S^3 + 5S^2 + 6S + 3}.$$ 15

(b) Write a set of differential equations in state form for coupled RLC network shown in fig. :



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[P. T. O.

2. Explain how to be formulate the optimal control problem? 20

3. Explain the principle of optimality, imbedding principle and principle of causality of Dynamic Programming. 20

4. (a) Find optimal control law $u^x(t)$ for the system :

$$\dot{x} = \begin{bmatrix} 0 & 1 \\ -10 & 0 \end{bmatrix} x + \begin{bmatrix} 0 \\ 10 \end{bmatrix} u$$

which minimize the performance index :

$$J = \frac{1}{2}\int_0^2 u^2 dt .$$ 10

(b) Find the external of the functional

$$J(x) = \int_0^{\pi/2} [\dot{x}_1^2 + 2x_1 x_2 + \dot{x}_2^2] dt.$$

Boundary conditions are :

$x_1(0) = x_2(0) = 0, \dot{x}_1(\pi/2)$ is free

$x_2(\pi/2) = -1$ 10

5. (a) A first order system is described by differential equation

$$\dot{x}(t) = u(t) + x(t)$$

it is desired to find the control law. Using Hamilton-Jacobi Bellman equation such that performance index

$$J(x) = \frac{1}{4}x^2(T) + \int_0^T \frac{1}{4}u^2(t) dt$$

and final time T is specified. 10

(b) Give formulation of continuous linear regulator problems using state variable approach. 10

6. (a) Find the external curve for the functional

$J(x) = \int_{t_0}^{t_f} [1 + \dot{x}^2(t)]^{1/2} dt$, the boundary condition $t_0 = 0$,

$x(0) = 0$ are specified t_f and $x(t_f)$ are free, but $x(t_f)$ is required to lie on the line

$$Q(t) = -5t + 15$$ 10

(b) Explain the pontryagin's minimum principle and state inequality constraints. 10

7. (a) A first order system is described by the differential equation

$$\dot{x}(t) = 2x(t) + u(t).$$

it is desired to find control law using Riccati equation that minimize the performance index :

$J = \int_0^{t_1} \frac{1}{2}(3x^2 + \frac{1}{4}u^2)dt$ t_1 specified. 10

(b) Drive the Riccati equation of continuous time linear state Requator. 10

8. (a) What is the sub-optimal control? Define the methods of sub-optimal control for discrete time system. 12

(b) Write a short note on parameter optimization. 8

100