Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

(A constituent unit of MAHE, Manipal)

SECOND SEMESTER M.TECH. (CONTROL SYSTEMS)

END SEMESTER EXAMINATIONS, APRIL - 2018

SUBJECT: OPTIMAL CONTROL [ICE 5234]

Duration: 3 Hour Max. Marks:50

Instructions to Candidates:

- Answer **ALL** the questions.
- Missing data may be suitably assumed.

1A Define optimum policy. 2

1B Write the cost function for the state regulatory problem and tracking problem with its objectives. 3

1C Derive the necessary equation to be solver to determine an extremal with both t_f and $x(t_f)$ are fixed. 5

2A Find $X^*(t)$, for the given cost function 5

$$J(x)=\int_0^{\frac{\pi}{2}}[\dot{x}_1^2(t)+\dot{x}_2^2(t)+2x_1(t)x_2(t)]dt \text{ , with } x_1(0)=0; x_2(0)=0; x_1\left(\frac{\pi}{2}\right)=1; x_2\left(\frac{\pi}{2}\right)=-1$$

2B With a neat sketch and necessary steps explain the piecewise smooth extremal and derive for the corner equation. 5

3A Brief the steps involved in the fuel optimal control with its cost function, necessary conditions and diagrams. 5

3B When final time t_f and final stage $x(t_f)$ are free, and optimal trajectory to determine an $\theta(t)$, find $x^*(t)$ for the given cost function and initial conditions. Also find the final time (t_f) and corresponding $x(t_f)$ values. 5

$$J(x)=\int_{to}^{tf}[\sqrt{1+\dot{x}^2(t)}]dt \text{ with initial condition } t_0=0 \text{ and } x(0)=0 \text{ , also given } \theta(t)=-5t+15$$

4A Derive expression for the final control law for the continuous linear regulator problem using the H-J-B equation and specified boundary conditions. 5

4B Using Matrix Ricatti equation formulate necessary equation to be solved to obtain the optimal control law for the given system and cost function. 3

$\dot{x}_1 = x_2(t)$

$\dot{x}_2 = 2x_1(t) - x_2(t) + u(t)$

Cost function is $J = \int_o^T [x_1^2(t) + \frac{1}{2}x_2^2(t) + \frac{1}{4}u^2(t)]dt$.

4C Specify the necessary condition to be satisfied and the transformation in Riccati equation when the optimal control problem is of infinite duration. Also comment on the transformation. 2

5A Explain the structure of time optimal control algorithm with a neat sketch and its final control law. 4

5B With neat phase plane trajectories and control sequence explain the switching curve and its region. 6

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