Paper Code: EIC-801	**Roll No.**										

B.Tech.
(SEM VIII) EVEN SEMESTER EXAMINATION, 2015-16
OPTIMAL CONTROL SYSTEMS

[Time: 3 hrs.] **[Max. Marks: 100]**

Note:-Attempt all questions. All questions carry equal marks.

1. Attempt any four parts of the following: - **[5x4=20]**

(a) Define an optimal control problem.Also discuss its various components.
(b) For the system x=u
With,|u|≤1, find the control which drives the system from an arbitrary initial state to the origin and minimizes
$$J = \int_0^{t1} | u(t) | dt;$$ t_1 is free.

(c) Draw and explain the flow chart of the steepest descent algorithm.
(d) What is pontrygin's minimum principle? Discuss how an optimal control input is obtained with a suitable problem, with this approach.
(e) How dynamic programming does employ principle of optimality for solving the multistage decision process.
(f) Find the external of the functional
$$J(x) = \int_0^{\frac{\pi}{4}} (x_1^2 + \dot{x}_2^2 + \dot{x}_1 \dot{x}_2) dt$$
The boundary conditions are
$$x_1(0) = 0, x_1(\pi/4) = 1, x_2(0) = 0, x_2(\pi/4) = -1$$

2. Attempt any four parts of the following: - **[5x4=20]**

(a) Discuss the solution of 'Output regulator' and 'Tracking Control' problems using the results of 'linear state regulator' problem.
(b) Find the optimal control law for the system
$$\begin{bmatrix}\dot{x}_1\\ \dot{x}_2\end{bmatrix} = \begin{bmatrix}0 & 1\\ 1 & 1\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix} + \begin{bmatrix}1 & 1\\ 0 & 1\end{bmatrix}\begin{bmatrix}u_1\\ u_1\end{bmatrix}$$
With performance index
$$J = \int_0^{\infty} (x_1^2 + u_1^2 + u_2^2) dt$$
(c) Use the minimum principle to show that it is necessary to use a bang controller to drive the system
$$\begin{bmatrix}\dot{x}_1\\ \dot{x}_2\end{bmatrix} = \begin{bmatrix}0 & 1\\ 0 & 0\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix} + \begin{bmatrix}0\\ 1\end{bmatrix}u$$
From an initial state $x_1=1, x_2=0$ to a zero final state if the input variable is constrained. Find such a control if $-1 \le u(t) \le 2$.

(d) Discuss the algorithm for the solution of 'Discrete-time Linear State Regulator' problem.
(e) It is desired to determine the control law that minimizes the performance measure:
$J = 1/2 \int_0^{t_1} (3x^2 + 1/4u^2) dt, t_1$ is specified for a first order system with differential equation given as
$$\dot{x} = 2x(t) + u(t)$$
(f) Derive the Matrix Riccati equation for a continuous time regulator problem.

3. Attempt any two parts of the following: - **[10x2=20]**

(a) Determine the Kalman gains K(k) for, k=1 to 2 for the following estimation problem:

$$x(k+1) = \begin{bmatrix} 1 & 1 \\ 0 & 1 \end{bmatrix} x(k) + w(k)$$

$$y(k) = x_1(k) + v(k)$$

$$Q(k) = \begin{bmatrix} 0 & 0 \\ 0 & 0.5 \end{bmatrix}, \quad R(k) = 1, \quad P_0 = \begin{bmatrix} 5 & 0 \\ 0 & 5 \end{bmatrix}$$

(b) What are stochastic processes? Give examples. How a control problem is classified between stochastic and deterministic?

(c) For the time-invariant system:

$$\dot{x}(t) = x(t) + w(t)$$
$$y(t) = x(t) + v(t)$$
$$Q = 4 \propto, \qquad R = \propto, \qquad \propto = constant$$

Find the time-invariant filter. Show that the answer is independent of a.

4. Attempt any two parts of the following: - **[10x2=20]**

(a) Discuss the microcomputer controlled DC motor system. Also draw the relevant diagrams.

(b) What are 'Digital Signal Processors? Discuss the block diagram 'TMS320 DSP' manufactured by Texas instruments.

(c) What do you mean by a Microprocessor? Explain its architecture.

5. Attempt any two parts of the following: - **[10x2=20]**

(a) Discuss the 'Transfer Characteristics' and block diagram representation of a quantizer.

(b) Explain how state variable technique is used to analyze the least bound error of a quantized system.

(c) What do you mean by pole placement? Explain the closed loop pole placement. What effect does it have on the transient performance of the control system?