Printed Pages : 2 **Roll No.** | | | | | | | | | | | **NIC801**

B.TECH.

THEORY EXAMINATION (SEM–VIII) 2016-17

OPTIMAL CONTROL SYSTEMS

Time : 3 Hours ***Max. Marks : 100***

Note : *Be precise in your answer. In case of numerical problem assume data wherever not provided.*

SECTION-A

1. Attempt *all* questions in brief. **2 x 10 = 20**

a. Describe the various theoretical approaches to design the optimal control system.
b. Define minimum time problem.
c. What is sampling period sensitivity?
d. Explain optimal feedback control.
e. What is principle of causality?
f. Define uniqueness of control.
g. What is Kalman filter?
h. Write the relation between optimal estimation problem and optimal regulator problem.
i. Draw the block diagram of a microcomputer-controlled dc motor.
j. Define main features of DSP processors.

SECTION-B

2. Attempt any *five* of the following: **10 x 5 = 50**

a. Suppose that the system

$$\dot{x}_1(t) = x_2(t)$$
$$\dot{x}_2(t) = u(t)$$

is to be controlled to minimize the performance measure

$$J(x,u) = \frac{1}{2}\int_1^2 u^2 dt$$

Find a set of necessary conditions for optimal control.

b. Let $f(x) = -x_1 x_2$ and let $g(x) = x_1^2 x_2^2 - 1$. What are potential candidates for minima of f subject to the constraint $g = 0$?

Show that the points $\left(\frac{1}{\sqrt{2}}, \frac{1}{\sqrt{2}}\right)$ and $\left(-\frac{1}{\sqrt{2}}, -\frac{1}{\sqrt{2}}\right)$ actually provide the minima.

c. A first- order system

$$\dot{x} = -x + u$$

Is to be controlled to minimize

$$J = \frac{1}{2}\int_0^1 \left(x^2 + u^2\right) dt$$

Find the optimal control law.

d. Define the Hamilton-Jacobi procedure for solving optimal control problem using a suitable example.

e. Explain the optimal estimation for linear discrete time system.

f. Consider the process described by first order stochastic differential equation

$$\dot{x}(t) = \frac{-1}{\tau} x(t) + w(t)$$

Where $w(t)$ is scalar white noise with constant intensity μ; $x(0) = x^0$ is a scalar stochastic Variable with mean zero and variance σ^2. Find the variance of the process when (i) $t \geq 0$ (ii) $t \to \infty$.

g. Explain the effects of finite word length and quantization on controllability and close loop pole placement.

h. What is microprocessor control of control system? Also define the properties of Galil DMC-105 board .

SECTION-C

Attempt any *two* of the following: **2 x 15 = 30**

3. Consider the system

$$x(k+1) = 0.368x(k) + 0.632u(k)$$

Find the control sequence so that the following performance index is minimized:

$$J = x^2(N) + \sum_{k=0}^{3} [x^2(k) + u^2(k)]$$

Also find the control sequence when $N \to \infty$.

4. Find the optimal control law for the system

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

With the performance index

$$J = \int_0^{\infty} (x_1^2 + u_1^2 + u_2^2) dt$$

5. What is a digital signal processor? Also define the properties of digital signal processors.