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M. Tech.

DIGITAL CONTROL SYSTEMS

SUBJECT CODE : PEE - 504

Paper ID : [E0484]

[Note : Please fill subject code and paper ID on OMR]

Time : 03 Hours

Maximum Marks : 100

Instruction to Candidates:

- 1) Attempt any Five questions.
- 2) All questions carry equal marks.
- 3) Missing data, if any can be suitably assumed.

- Q1) (a) What are Digital control systems and how are these different from Analog control systems? With an aid of a block diagram show basic elements of a digital control system and give functioning of these elements.
- (b) What is meant by sampling and hold operations? What are types of sampling operations? In case of an Ideal sampling show that L.T of sampled output, $f^*(t)$ is given by

$$F^*(s) = \sum_{n=0}^{\infty} f(nT) e^{-nsT}$$

where T is sampling period.

- Q2) (a) What are hold-operation? Why is hold operation needed in a digital control systems? Derive expression of T.F. of a simple type of hold-circuit.
- (b) Based on "impulse response" and "frequency response" give a comparison of various hold-circuits.

- Q3) (a) Why is z-transform useful in analysis of digital control systems? Define Pulse T.F. Also mention limitations of z-transform.
- (b) Enumerate steps involved in obtaining z-transform of a function, $f(t)$. Obtain z-transform of the following :

$$f_1(t) = e^{-\alpha t} \sin \beta t$$

$$f_2(t) = \cos \omega t.$$

- Q4) (a). Define stability of digital control systems. Enumerate various methods used for stability investigation of such systems. Why is R-H criterion not directly applicable in stability analysis of such systems - explain.

- (b) Solve the following difference equation using z-transform :
 $y(k+2) - 0.1 y(k+1) - 0.2 y(k) = u(k+1) + u(k)$ with $-y(0) = 0$ &
 $y(1) = 0, k = 0, 1, 2, \dots$

- Q5)** (a) Discuss working of a Digital position control system with a simplified block diagram.
 (b) Discuss the stepping motor-operation with control action included and disk drive system incorporated.

- Q6)** (a) What is need of compensator in a digital control system? Discuss the procedure of design of digital controllers.
 (b) The pulsed TF of a digital control system without compensation is

$$\text{given by } G_{ho} G_p(z) = (1 - z^{-1}) Z \left[\frac{880}{s^2(s + 8.8)} \right]$$

use Bilinear transformation & design a lead controller to meet the following requirements :

Phase margin = 45° &
 resonance peak $M_p \simeq 6.7$.

- Q7)** (a) Show state variable representation of an analog control system described by an input-output relation in form of a differential equation. Also derive TF of the system from the state variable model so obtained.
 (b) An analog system is described by following SE and OE of the form

$$\begin{cases} \dot{x}_1 = x_2 \\ \dot{x}_2 = -2x_1 - 3x_2 + u \end{cases} \quad \text{SE}$$

$$y = x_1 : \quad \text{OE}$$

Obtain TF and find eigen values of the system.

- Q8)** (a) Develop state variable description of a digital control system with
 $u(k)$ = input signal at k th instant
 $y(k)$ = output-signal at k th instant
 & $x(k)$ = state variable at k th instant
 Also obtain TF of above system.
 (b) Give state variable model of a digital control system if input-output relation of the system dynamics is described by differential eg.
 $y(k+3) + 5y(k+2) + 3y(k+1) + 2y(k) = u(k)$.

