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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 $-y(0) = 0$ & $y(1) = 0$, $k = 0,1,2,.....$

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 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 Mp $\simeq$ 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

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

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

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 kth instant
$y(k)$ = output-signal at kth instant
&$x(k)$ = state variable at kth 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.
$y(k+3) + 5y(k+2) + 3y(k+1) + 2y(k) = u(k)$.