B. Power Engineering 4th Year Second Semester Examination, 2024
Digital Control Systems

Full Marks :100 **Time: 3 hrs**

Group A
(Answer Q1 and any one of Q2 or 3)

1. Derive the Z transform of an **pulse train of height H** with a periodicity **T and duty cycle D.** Assume that the sample time chosen is such that both **T** and **D** are integer multiples of it **20 CO(1)**

Or

Write a MATLAB code to

(i) Define a Transfer Function $G(s) = \frac{5(s+0.5)}{s(s+1)(3s+1)}$ in continuous time

(ii) Convert the system in (i) into a Discrete System with a sampling time of 0.01 sec and ZoH discretization.

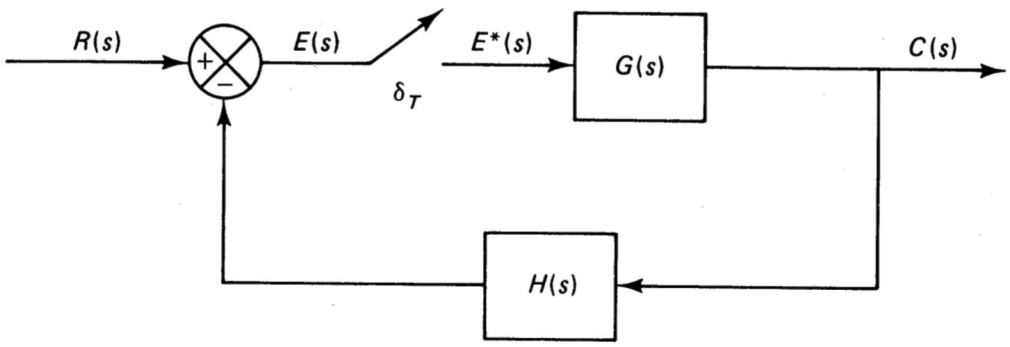
Does ZoH discretization induce a lag? Substantiate your answer **4+8+8 CO(1)**

2. Deduce a map between s and z plane for a sample time **T** using Tustin substitution. Hence deduce the discrete equivalent of $G(s) = \frac{5}{(0.1s+1)(2s+1)}$ with suitable choice of a sampling time. **10+10 CO(2)**

3. Derive the s-plane equivalent a pole at $z = -1$ and $z = 1$ in the Z plane. **10+10 CO(2)**

Group B
Answer ALL Questions

4. Derive the Pulse Transfer function $\frac{C(z)}{R(z)}$ for the closed-loop sampled-data system shown below



20 CO(3)

Or

In the Figure above consider that the discrete equivalent of G(s) i.e. $G(z) = \frac{10z+5}{(z-1)(z-0.2)}$ and H(s)=1.Derive the closed-loop transfer function $\frac{C(z)}{R(z)}$ and express it in the form of a difference equation.

5. Using Jury Test examine the stability of the discrete system defined by

$$P(z) = z^3 - 1.1z^2 - 0.1z + 0.2 = 0$$

Or

From first principles, derive **a discrete state-space representation** of a continuous time Transfer function denoted by $G(s) = \frac{0.8}{s(s+2)}$. Hence deduce if this system is stable. Consider a sampling time of T= 1s **20** CO(4)

6. Derive from first principles the discrete equivalent of a Continuous Time PID controller defined by $G(s) = (k_p + \frac{k_i}{s} + k_d s)$ discretized with a sample time T. What are the requirements for choice of T. **12+8** CO(5)

Or

Consider a CT system $G(s) = \frac{K}{(Ts+1)}$ controlled by a PI controller $\left(K_p + {}^{K_i}/_{s}\right)$.Develop a sequence of MATLAB codes to choose the appropriate sample time for dicretization and design the discrete closed loop feedback controller (unity feedback- controller in forward path) either by direct method, analytical method for a suitable indirect method.

20 CO(5)