Ref. No. : Ex/IEE/PC/H/T/321/2022

B.E. Instrumentation & Electronics Engg. 3rd Year, 2nd Semester Examination 2022

SUBJECT : Advanced Process Control

Time : *03 hours* Full Marks : *100*

[CO1] :

1. *a*) What is meant by an ideal or impulse sampler ? 2

   b) Prove that a practical sampler is equivalent to an ideal sampler followed by an attenuator. 5

   c) A Zero-order Hold (ZOH) introduces an additional dead-time of $0.5T$ (T is the sampling period) in discrete time control systems – *Justify* 3

2. For the discrete time system described by the difference equation

   $$x(k+2)-3x(k+1)+2x(k)=u(k).$$

   Find its response $x(k)$ for the unit-impulse input $u(k)$ at $k=0$, when $x(k)=0$ for $k\le 0$. . 10

   OR

   A system is described by the following difference equation:

   $$x(k+2)-1.5x(k+1)+0.5x(k)=u(k),$$

   where $x(0)=1$ and $x(1)=\frac{5}{2}$. Find its response $x(k)$ for a unit-step input $u(k)$ applied at $k=0$. 10

[CO2] : Answer *any* **Four** questions (from 3 to 7):

3. Why Routh-Hurwitz stability criterion cannot be directly applied for sampled data control systems ?
   For the characteristic equation, $F(z)=z^4-2z^3+1.5z^2-0.1z-0.02=0$, determine the stability of the system using Jury's test. 2+10

4. Using the bilinear transformation $r=\dfrac{z-1}{z+1}$ and Routh-Hurwitz criterion test the stability of the discrete time control system with characteristics equation: $F(z)=z^4-1.2z^3+0.07z^2+0.3z-0.08=0$. 12

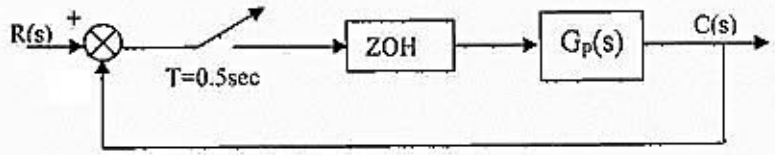
5. *a*) Find the pulse transfer function of the digital PID controller considering 'backward difference' and 'trapezoidal integration' rules, and draw the parallel realization diagram of its digital program implementation. 7

   b) Consider the digital controller defined by

   $$D(z)=\frac{M(z)}{E(z)}=\frac{5(0.25z^{-1}+1)}{(1-0.5z^{-1})(1-0.1z^{-1})}$$

   Draw the parallel realization diagram of its digital program implementation. 5

6. For the close-loop system shown below:



Find the unit step response of the system, when $G_p(s) = \frac{1}{(S+1)}$. 12

7. Discuss about the steady state error analysis of discrete time control systems. 12

[CO3]:

8. *a*) What are the approaches to solve the problem of loop interaction in multivariable control systems ? Derive the relative gain array (RGA) for a 2×2 (TITO) multivariable control system. 2+6

   b) In what situation decoupling is required in a multivariable control system? Design the decoupler for a 2×2 closed-loop control system for a complete decoupling. 2+ 6

[CO4]:

9. *a*) Providing the block diagram of a simple fuzzy logic controller (FLC) explain the role of its various computational blocks. 8

   b) Write down the steps involved in designing a Fuzzy Logic Controller (FLC). Mention the flexibilities and limitations of FLC design. 4+4

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