PURWANCHAL UNIVERSITY
VI SEMESTER FINAL EXAMINATION- 2003

LEVEL : B. E. (Electronics & communication)
SUBJECT : BEG338EC,Digital Control System.

Full Marks: 80
TIME: 03:00 hrs **Pass marks:** 32

Candidates are required to give their answer in their own words as far as practicable.
All questions carry equal marks. The marks allotted for each sub-questions is specified along its side.

Attempt any FIVE questions.

Q. [1] [a] Explain the principle and features of digital control systems in details. [8]

[b] Explain the properties of Z-transform. Obtain the inverse Z-transform of X(s) = $\dfrac{z^{-2}}{\left(1-z^{-1}\right)^3}$ [8]

Q. [2] [a] Explain the root locus method with example. [8]

[b] Given X(s) = $\dfrac{1-e^{-TS}}{S}G(s)$

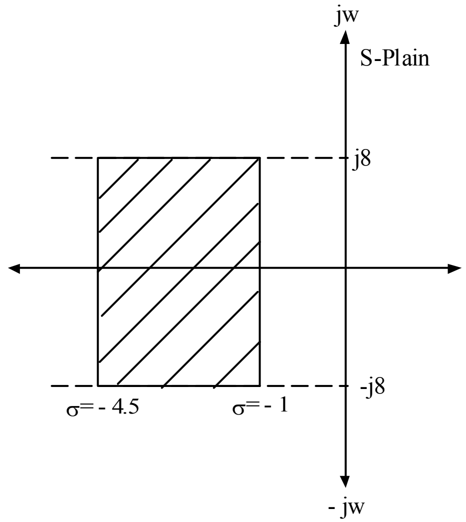
Prove that X(z) = $\left(1-z^{-1}\right)Z\left[\dfrac{G(s)}{S}\right]$ [8]

Q. [3] [a] Explain the control system controller in detail. [8]

[b] For the unity feedback control system with open loop transfer function G(s) = $\dfrac{k(0.3679z+0.2642)}{(z-0.3679)(z-1)}$ Determine the range of k for stability by sing Jury stability Test. [8]

Q. [4] [a] Explain the PID controller design with example. [8]

[b] For given region in S-plane, draw the corresponding regions in z-plane. Assume that T= 0.4 sec.



Q. [5] [a] Explain in detail of pulse Transfer function Matrix. [8]

[b] Determine the stability of origin of the following discrete-time system: [8]

$$\begin{bmatrix} x_1(K+1) \\ x_2(K+1) \\ x_3(K+1) \end{bmatrix} = \begin{bmatrix} 1 & 3 & 0 \\ -3 & -2 & -3 \\ 1 & 0 & 0 \end{bmatrix} \begin{bmatrix} x_1(K) \\ x_2(K) \\ x_3(K) \end{bmatrix}$$ [8]

Q. [6] Write a short note on: [4×4=16]

[a] Signal Sampling.
[b] Frequency Response Method.
[c] Phase-lag Compensation Design.
[d] Discretization of the continuous-time States-space Equation.

PURWANCHAL UNIVERSITY
VI SEMESTER FINAL EXAMINATION- 2004
LEVEL : B. E. (Electronics & communication)
SUBJECT : BEG338EC,Digital Control System.
Full Marks: 80
TIME: 03:00 hrs **Pass marks:** 32

Candidates are required to give their answer in their own words as far as practicable.
All questions carry equal marks. The marks allotted for each sub-questions is specified along its side.
Attempt any FIVE questions.

Q. [1] [a] Explain Data Acquisition system and Data distribution system with necessary figures. [8]
[b] Determine the z-transform of the following continuous time sequences:
[i] y(t) = x(t-nT) [ii] $x(t) = e^{-at} \cos \omega t$

Q. [2] [a] Solve the following difference equation:
X(k-2)-x(k-1)+0.25x(k) = u(k-2)
Where x(0)=1, x(k) = 0 for K<0 and u(k) is a unit step function given by u(k) =1 for k>0.
[b] Consider the zero order hold circuit succeeded by the plant with transfer function G(s). Explain how you would determine the z-transform of such combined system.

Q. [3] [a] Consider the following discrete time control system:

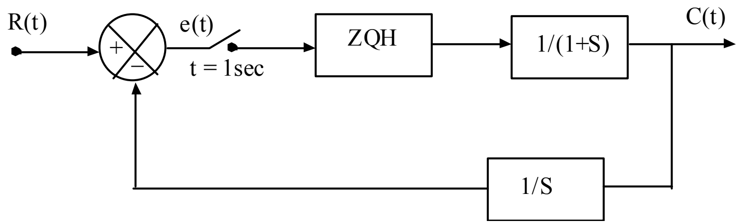


Fig. 3[a]

Determine the output sequence c(k) if r(t) is the step Input.
[b] Assume the digital filter described by the following difference equation:
y(k) = 0.2y(k-1)+0.3y(k-2) = 1.4x(k)+1.5(k-1)
Draw the block diagram for the filter using standard programming method. [8]

Q. [4] [a] Consider the discrete time unity feedback control system with open loop transfer function G(z) = K(0.4z+0.3)/(Z-0.4)(Z-1) Determine the value of gain K that will cause sustained oscillation in the output. Also find the frequency of sustained oscillation .Assume sampling period T = 1 sec. [8]

[b] Explain the effects of sampling period on the transit and steady state response of sampled data control system. [8]

Q. [5] Obtained the state of the following pulse transfer function system in the diagonal canonical form: [16]
$Y(z)/U(z) = (z+4)/(z^3+6z^2+11z+6)$

Q. [6] Consider the digital control system as in Fig. (6) below plot the root loci as the gain K is varied form 0 to ∞ .Determine the critical value of K for stability.. the sampling period is 0.1 sec i.e T=0.1, [16]

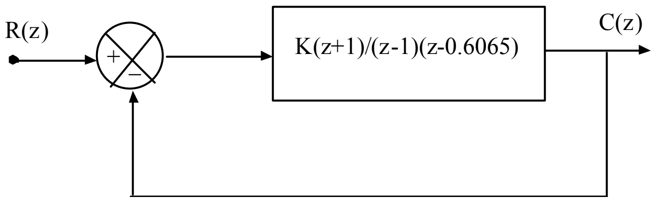


Fig.[6]

PURWANCHAL UNIVERSITY
VI SEMESTER B EXACK-PAPER EAMINATION- 2004

LEVEL : B. E. (Electronics & communication)
SUBJECT : BEG338EC,Digital Control System.
Full Marks: 80
TIME: 03:00 hrs **Pass marks:** 32

Candidates are required to give their answer in their own words as far as practicable.
All questions carry equal marks. The marks allotted for each sub-questions is specified along its side.

Attempt any FIVE questions.

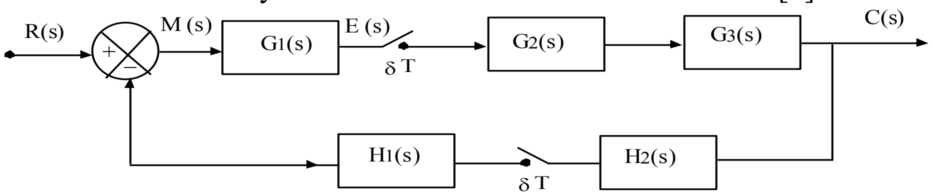
Q. [1] [a] Determine the z-transform of the following continuous time sequences. [8]
[i] y(t) = x[t-nT] [ii] $x(t) = e^{-at}\cos wt$

[b] Given the differential equation [8]
X(k+2) = x(k+1)+x(k)
Where x(0) = 0, x(1) = 1, x(2) = 2, x(3) = 2, x(4) = 3

Prove that $\lim_{k \to \infty} \frac{x(k+1)}{x(k)} = \frac{1+\sqrt{5}}{2}$

Q. [2] [a] Show that the laplace transform of the impulse sampled signal x*(t) is same as the z-transform of the continuous signal x(t) if e^{sT} is defined as Z. [8]

[b] Obtained the discrete time output c(z) of the closed loop control system shown below. [8]



Also obtained the continuous time output.

Q. [3] [a] Explain the frequency response method with example.[8]

[b] Consider the system described by:

$$y(k) - 1.2y(k-1) + 0.07y(k-2) + 0.3y(k-3) - 0.08y(k-4) = x(k)$$

Where x(k) is the input and y(k) is the output of the system.
Examine if all the roots of the characteristics equation of the above system lie within the unit circle. [8]

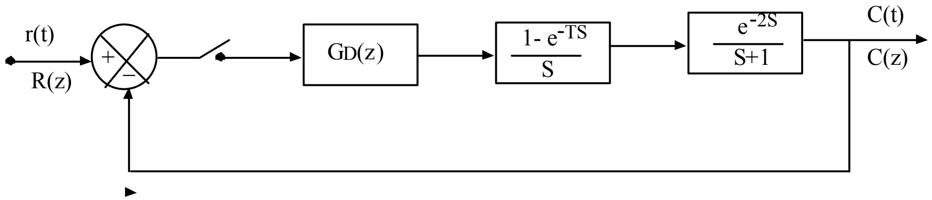
Q. [4] [a] State the function of Data Hold circuit. Show that the transfer function of zero order-hold circuit is

$$G_{\eta 0} = \frac{1-e^{-ST}}{S}$$

[b] Obtained the state space representation of the following pulse transfer function in controllable canonical form.

$$\frac{Y(s)}{U(s)} = \frac{1+3z^{-1}+5z^{-2}-4z^{-3}}{1+2z^{-1}+7z^{-2}+5z^{-3}} \quad [8]$$

Q. [5] The given plant is of first order with dead time = 2 sec and sampling period = 1 sec.
Design a digital PI controller such that the dominant closed-loop poles having damping ratio = 0.5. Number of samples per cycles of damped sinusoidal oscillation is 10. Obtained the response of the system to a unit-step input. Also obtained K_v. [16]



Q. [6] Write short note on: [4×4=16]

[a] Sampling Theorem.
[b] Root Locus Method
[c] Phase-lead Compensator Design.
[d] Features of digital control system.

PURWANCHAL UNIVERSITY
VI SEMESTER FINAL EXAMINATION- 2005

LEVEL : B. E. (Electronics & communication)
SUBJECT : BEG338EC,Digital Control System.

Full Marks: 80
TIME: 03:00 hrs **Pass marks:** 32

Candidates are required to give their answer in their own words as far as practicable.
All questions carry equal marks. The marks allotted for each sub-questions is specified along its side.

Attempt ALL questions.

Q. [1] [a] Explain how original signal can be reconstructed form sampled signal. [8]
[b] Given $X(s) = 1/s^2 (s+1)$. Obtained X(z) by using convolution integral theorem. [8]

Q. [2] [a] [i] What are the criteria for stability in z-domain . [4]
[ii] Consider a closed lop system whose open loop transfer function is given as G(z) = (0.3z+0.2)/(z-0.3)(z-1). Determine the stability of the system. [4]
[b] Consider the discrete time control system shown in the fig. 2[b] . Obtain the discrete time output in terms of input and transfer function of the block. [8]

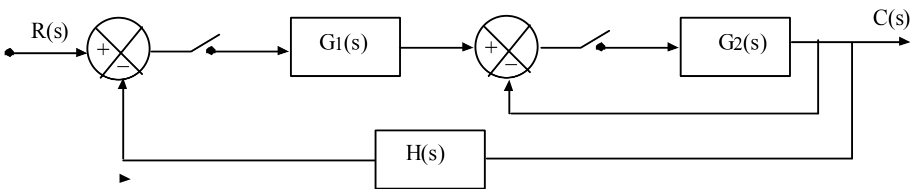


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Fig. 2[b]

Q. [3] [a] Derive the equation for steady state error due to ramp input for digital control system.
Draw the root loci for the system given by $G(z) = [kz/(z-1)][(1-e^{-T})]$. Assume the sampling time T = 0.5 sec.
[b] Solve the following difference equation by the use of z-transform method. [8]
X(k+2)+3x(k+1)+2x(k) = 0 , Given, x(0) = 0 & x(1) = 1.

Q. [4] [a] Obtain the stage transition matrix of the following discrete time system. [8]
X(k+1) = Gx(k)+Hu(k)
Y(k) = Cx(k) where,

$$G = \begin{bmatrix} 0 & 1 \\ -0.16 & -1 \end{bmatrix} \quad H = \begin{bmatrix} 1 \\ 1 \end{bmatrix} \quad C = \begin{bmatrix} 1 & 0 \end{bmatrix}$$

Then obtain the state x(k) and the output y(k) when input is u(k) =1 for k = 0,1,2 ……assume initial state is given by x(0) =

$$\begin{bmatrix} x_1(0) \\ x_2(0) \end{bmatrix} = \begin{bmatrix} 1 \\ -1 \end{bmatrix}$$

[b] Prove that P(z) = [C Adj (zI-G) H/ (zI-G)]+D [8]

Q. [5] [a] Consider a digital control system shown in the figure below. Design a digital controller such that dominant closed loop poles have a damping ration ξ of 0.4 and settling time of 2 se. the sampling time is assumed to be 2 sec. [8]

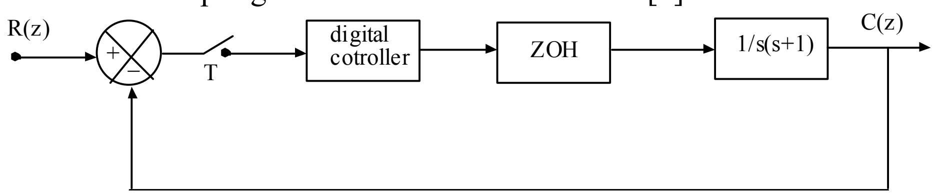


Fig. 5[a]

[b] Examine the stability of the following characteristic equation. [8]
$P(z) = z^4 - 1.2z^3 + 0.07z^2 + 0.3z - 0.8 = 0$

PURWANCHAL UNIVERSITY
VI SEMESTER BACK-PAPER EXAMINATION- 2005

LEVEL : B. E. (Electronics & communication)
SUBJECT : BEG338EC,Digital Control System.
Full Marks: 80
TIME: 03:00 hrs **Pass marks:** 32

Candidates are required to give their answer in their own words as far as practicable.
All questions carry equal marks. The marks allotted for each sub-questions is specified along its side.

Attempt any FIVE questions.

Q. [1] [a] Describe the Sample and hold circuit with block diagram. What is sampling theorem ? [6+2]

[b] Find the z-transform of $\frac{1-e^{-TS}}{S(1+S)}$ by using shifting theorem. [8]

Q. [2] [a] Determine the inverse z-transform of x(z) by using partial fraction methods: [8]

$$X(Z) = \frac{Z(1-e^{-aT})}{(Z-1)(Z-e^{-aT})}$$

[b] Write the conditions to be stable for the discrete control system, by plotting zeroes and poles is z-plane. What is Bilinear transformation. [6+2]

Q. [3] [a] Map the given z-plane into s-plane: [8]

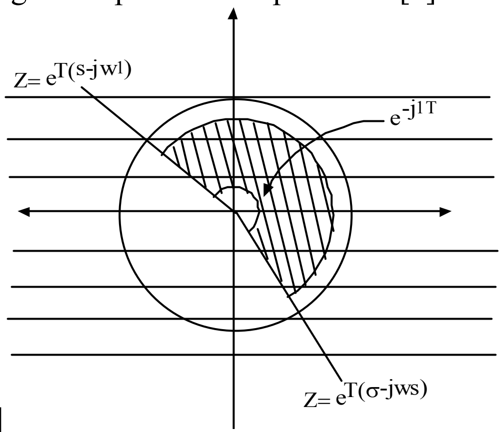


Fig.3[a]

[b] Derive the expression for static position error constant, static velocity error constant, and static acceleration error constant. [8]

Q. [4] [a] A control system has the system described by:
Y(k) -0.6y(k-1)-0.81y(k-2)+0.67y(k-3)-0.12y(k-4) = x(k)
Where x(k) is the input and y(k) is the output of the system.
Determine the stability of the system. [8]

[b] Define the following terms with neat and clean Transient response specification diagram: [8]
[i] Delay time [ii] Rise time.
[iii] Maximum overshoots [iv] Settling time.

Q. [5] [a] Plot the root locus diagram for T = 0.5 sec , T = 1 sec, T=2 sec. For digital control system as shown in fig.5[a]. [8]

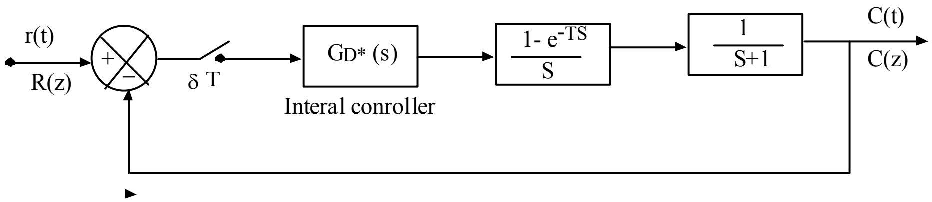


Fig.5[a]

[b] What do you mean by pulse transfer function matrix? Find pulse transfer function for G(s) = $\frac{1}{S(S+2)}$

Q. [6] [a] Design lead compensator by sing bode plot for given figure.

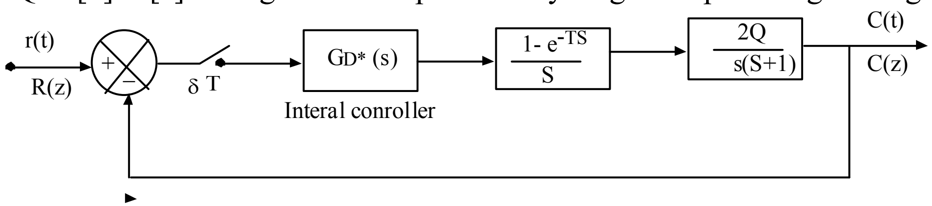


Fig. 6[a]

Make phase margin 50 ° and gain margin at least 10 dB. Take sampling period of 0.2 sec. [10]

[b] Determine the stability of the origin of the system for the following system: [6]

Q. [7] Write Short notes on (any Four): [4×4=16]

[a] Aliasing and Folding
[b] Zero and Pole Cancellation
[c] State Transition Matrix
[d] Initial and Final Value Theorem.
[e] Phase Lead and Phase Lag Compensator.
[f] Analog to Digital Converter.

PURWANCHAL UNIVERSITY
VI SEMESTER FINAL EXAMINATION- 2006

LEVEL : B. E. (Electronics & communication)
SUBJECT : BEG338EC,Digital Control System.

Full Marks: 80
TIME: 03:00 hrs **Pass marks:** 32

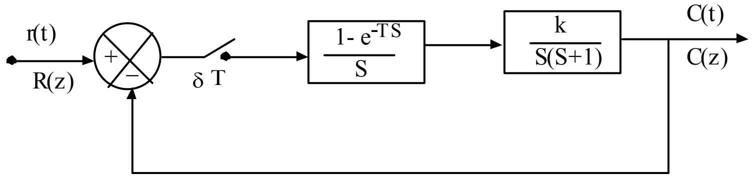
Candidates are required to give their answer in their own words as far as practicable.
All questions carry equal marks. The marks allotted for each sub-questions is specified along its side.
Attempt ALL questions.

Q. [1] [a] Obtain the inverse Z transform of $X(z) = \frac{Z^2}{(z+1)^2(z-e^{-aT})}$ by inversion integral method. [6]

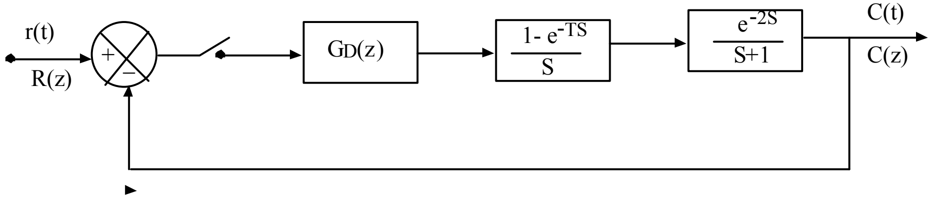
[b] Consider the different equation [10]
X(k+2)= x(k+1)+x(k) where,
X(0) = 0 and x(1) = 1, x(2) = 1, x(3) = 2, x(4)= 3……The series 0,1,1,2,3,5,8,13……is known as Fibonacci series. Obtain the general solution x(k) in a closed form . Show that the limiting value of $\frac{x(k+1)}{x(k)}$ as k approaches infinity is $\frac{(1+\sqrt{5})}{2}$, or approximately 1.6180.

Q. [2] [a] Consider the following characteristic equation $P(z) = z^3 - 1.3z^2 - 0.08z + 0.24 = 0$
Determine whether or not any of the roots of the characteristic equation lie outside the unit circle in z-plane. [6]

[b] Draw root locus diagram in the z-plane for system shown below for the sampling period T= 2 sec. [10]



Q. [3] Consider the digital control system shown in fig where plant is of first order and has a dead time of 2 se. The sampling period T is assumed to be 1 sec. Design a digital PI controller such that the dominant closed loop poles have a damping ration ξ of 0.5 and the number of samples per cycle of damped sinusoidal oscillation is 10. [16]



Q. [4] [a] Obtain the state transition matrix of the following discrete time system. [6]
X(k+1) =Gx(k) +Hu(k)
Y(k) = Cx(k)
Where,

$$G = \begin{bmatrix} 0 & 1 \\ -0.16 & -1 \end{bmatrix} \qquad H = \begin{bmatrix} 1 \\ 1 \end{bmatrix} \qquad C = \begin{bmatrix} 1 & 0 \end{bmatrix}$$

[b] Obtain the discrete time state and output equations and the pulse transfer function (when sampling period T =1) of the following continuous time system. $G(s) = \frac{Y(s)}{U(s)} = \frac{1}{S(s+1)}$ which may be represented in state space by equations. [10]

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ 0 & -2 \end{bmatrix}\begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u$$

$$y = \begin{bmatrix} 1 & 0 \end{bmatrix}\begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$

Q. [5] [a] Consider the digital filter defined by ,

$$G(s) = \frac{2 + 2.2z^{-1} + 0.2z^{-2}}{1 + 0.4z^{-1} - 0.12z^{-2}} \qquad [8]$$

Realize the digital filter in Ladder scheme.

[b] Explain how original signal can be reconstructed from sampled signal. [8]

PURWANCHAL UNIVERSITY
VI SEMESTER BACK-PAPER EXAMINATION- 2006

LEVEL : B. E. (Electronics & communication)
SUBJECT : BEG338EC,Digital Control System.
Full Marks: 80
TIME: 03:00 hrs **Pass marks:** 32

Candidates are required to give their answer in their own words as far as practicable.
All questions carry equal marks. The marks allotted for each sub-questions is specified along its side.

Attempt ALL questions.

Q. [1] [a] Explain discrete time control system with neat block diagram. [8]

[b] Prove that F*(s) = F (z). Obtained the z-transform of $x(k) = \sum_{h=0}^{k} a^h$. [4+4]

Q. [2] [a] By using inversion integral method. Obtain the inverse z-transform of $X(z)=(1+6z^{-2}+z^{3})/(1-z^{-1})(z-0.2z^{-1})$ [4]

[b] Explain how sampling time T affects the transient response and steady state of the discrete time control system.[4]

Q. [3] [a] Obtained the block diagram for the following pulse transfer function system by: [4]
[i] Standard programming [ii] Ladder programming
$Y(z)/X(z) = (2-0.6z^{-1})/(1+0.5z^{-1})$

[b] Obtain the closed loop transfer function of the system show in the figure below. [8]

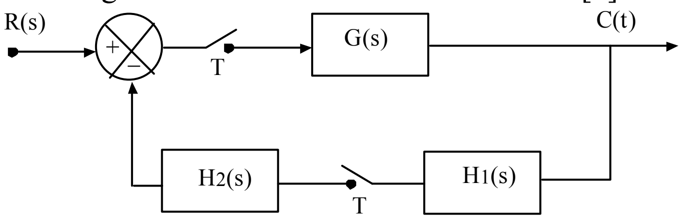


Fig.3[b]

Q. [4] [a] Obtain a state space representation of the following system.
$Y(z)/U(z) = (z^{-1}+2z^{-2})/(1+0.7z^{-1}+0.12z^{-2})$ [4+4]
[i] in diagonal canonical form.
[ii] in observable canonical form.

[b] Determine the stability of the following discrete time system. [4]

$$\begin{bmatrix} x_1(k+1) \\ x_2(K+1) \\ x_3(k+1) \end{bmatrix} = \begin{bmatrix} 1 & 3 & 0 \\ -3 & -2 & -3 \\ 1 & 0 & 0 \end{bmatrix} \begin{bmatrix} x_1(k) \\ x_2(k) \\ x_3(k) \end{bmatrix}$$

[i] Using Jury's stability test.
[ii] Using Liapunov stability analysis.

Q. [5] [a] Prove the pulse transfer function of a digital PID controller is [8]
$G_d(z) = k_p+k_i/(1-z^{-1})+k_d(1+z^{-1})$

[b] Consider a system shown in figure below. Design a digital controller such that dominant closed loop poles of the system will have damping ratio of 0.5. The number of samples per cycle of damped oscillation is 8. Assume that the sampling period T is 0.2 sec.

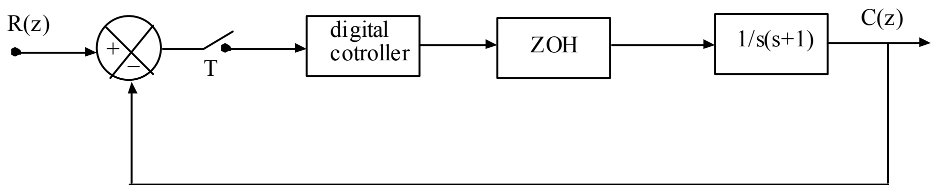


Fig. 5.[b]

PURWANCHAL UNIVERSITY
VI SEMESTER FINAL EXAMINATION- 2007

LEVEL : B. E. (Electronics & communication)
SUBJECT : BEG338EC,Digital Control System.

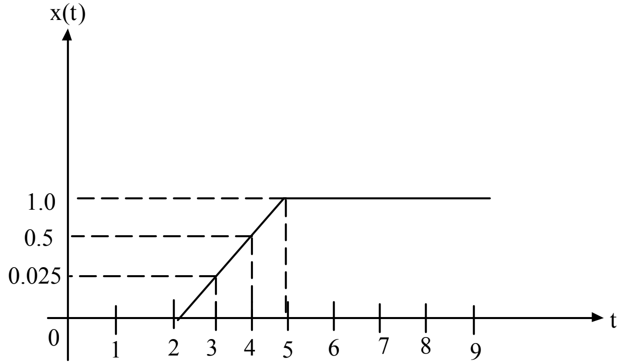
Full Marks: 80
TIME: 03:00 hrs **Pass marks:** 32

Candidates are required to give their answer in their own words as far as practicable.
All questions carry equal marks. The marks allotted for each sub-questions is specified along its side.

Attempt any FIVE questions.

Q. [1] [a] Describe the basic block of digital controllers in control system. [8]

[b] Obtain the z-transform of the curve x(t) shown in Fig. 1[b]. [8]



Q. [2] [a] Consider the difference equation:
X(k+2)-1.3679x(k+1)+0.3679x(k) = 0.3679 u(k+1)+0.2642 u(k).
Where x(k) is the output and x(k) = 0 for K ≤ 0 and where u(k) is the input and is given by
u(k) = 0 , k<0
u(0) = 1
u(1) = 0.2142
u(2) = -0.2142
u(k) = 0, k = 3, 4, 5………..
Determine the output x(k). [10]

[b] Obtain the inverse z-transform of

$$X(z) = \frac{z^{-2}}{(1-z^{-1})^3}$$ by the use of inversion integral method. [6]

Q. [3] [a] Consider the discrete-time unity feedback control system (with sampling period T =1 sec) whose open loop pulse transfer function is given by
G(z) = [k(0.3679z+0.2642)]/[(z-0.3679)(z-I)]
Determine the range of K for stability by use of the jury stability test. Also calculate the frequency of sustained oscillation. [8]

[b] Consider the digital control system shown in Fig. 3[b] . Plot the root loci as the gain K is varied from 0 to ∞ . Determine the critical value of gain k for stability. The sampling period is 0.1 sec or T 0.1. What value of gain K will yield a damping ratio ξ of the closed loop poles equal to 0.5? [8]

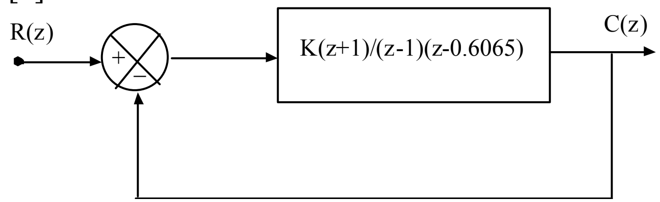
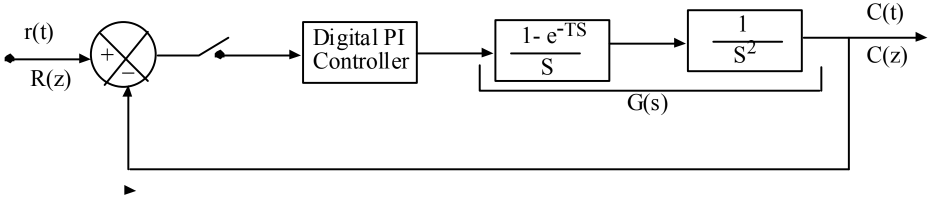


Fig. 3[b]

Q. [4] [a] Design a digital proportional-pulse derivative controller for the plant whose transfer function is $1/s^2$ as shown in Fig. [4] . It is desired that the damping ration ξ of the dominant closed loop poles be 0.5 and the undamped natural frequency be 4 rad/sec. the sampling period is 0.1 sec or T = 0.1 sec. After the controller is designed, determine the number of samples per cycle of damped sinusoidal oscillation. [16]



Q. [5] The system is given as $\frac{y(s)}{u(s)} = \frac{z+1}{z^2 + 1.3z + 0.4}$ [8]

Find the state-space representations in controllable, observable and diagonal canonical form. [8]

[b] Define pulse Transfer function matrix. Also derive an expression to represent it. [8]

Q. [6] Write short notes on (any FOUR): [4×4=16]

[a] Sampled and Hold circuit.

[b] Shifting Theorem.

[c] Transient and steady sate response

[d] Frequency response method.

[e] Signal to quantization noise ratio.

PURWANCHAL UNIVERSITY
VI SEMESTER BACK-PAPER EXAMINATION- 2007
LEVEL : B. E. (Electronics & communication)
SUBJECT : BEG338EC,Digital Control System.
Full Marks: 80
TIME: 03:00 hrs **Pass marks:** 32

Candidates are required to give their answer in their own words as far as practicable.
All questions carry equal marks. The marks allotted for each sub-questions is specified along its side.

Answer the questions.

Q. [1] [a] What is the difference between discrete –time signal and digital signal? Describe three basic operations for converting analog signal into digital signal. [2+6]
[b] Obtain the z-transform of a coskπ with its ROC. [6+2]

Q. [2] [a] Obtain the inverse z-transform of $X(z)=[z^2-z+2]/[(z-1)(z^2-z-1)]$. By use of the partial fraction expansion method. [8]

[b] Obtained the closed loop pulse transfer function fo the system shown below.

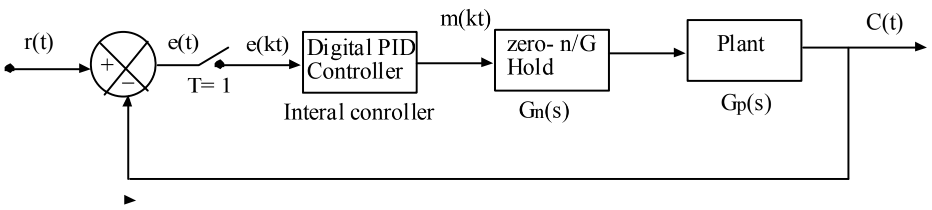


Fig. 2[b]

When the digital controller is a PID controller with $k_p=1$, $k_D=0.2$ and $G_p(s) = 1/[s(s+1)]$

Q. [3] [a] Obtain the response y(kT) of the following system $Y(s)/X^*(s) =1/[(s+1)(s+2)]$ Where x(t) is the unit step function and y(t) is the impulse-sampled version . Assume that the sampling period is 0.1 sec.

[b] Show that if the characteristics equation for a closed loop system is $1+ KB(z)/A(z) = 0$, Where A(z) and B(z) do not contain K , then the breakaway and break-in points can be determined from the roots of
$dK/dz = -[A'(z)B(z)-A(z)B'(z)]/B^2(z) =0$
where, the primes indicate differentiation with respect to z .

Q. [4] [a] Consider the digital control system shown in fig 4. Design a digital controller in the ω plane such that the phase margin is 50^0,the gain margin is at least 10 dB and the static velocity error constant k_v is 2 sec^{-1} Assume that the sampling period is 0.2 sec or T= 0.2 sec.

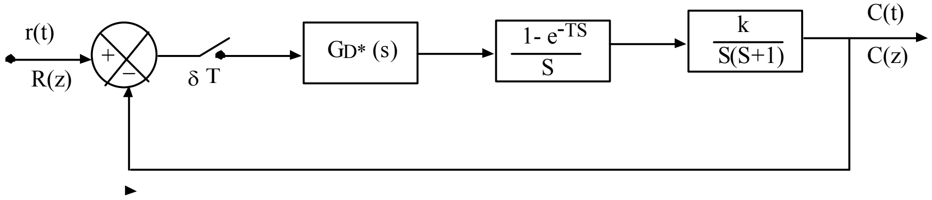


Fig. [4]

Q. [5] [a] Determine the stability of the origin of the following discrete time system. [8]

$$\begin{bmatrix} x_1((K+1)T) \\ x_2((K+1)T) \end{bmatrix} = \begin{bmatrix} \cos T & SinT \\ -SinT & \cos T \end{bmatrix} \begin{bmatrix} x_1(kT) \\ x_2(kT) \end{bmatrix}$$

[b] Explain the effect of sampling period on the transient and steady state response of sampled data control system [8]

