COLLEGE OF ENGINEERING & TECHNOLOGY

Department : Electrical & computer Control Engineering
Lecturer : Prof. Dr. Medhat El Singaby
Course : Discrete-Time control systems
Course Code : EE 511 **Marks** : 40
Date : 20/1/2015 **Time** : 2 hours

Final Exam

Answer the following questions:

Question no.1 A-1

a) Find e (0) and e (10) for

$$E(z) = \frac{1}{(z-1)(z-0.3)}$$

By using the partial fraction technique, check the value of e (0) by the initial value theorem.

b) Solve the given difference equation for y(K) using
   i. The sequential technique till K = 4
   ii. The z - transform

Will the final value theorem give the correct values of y(K) as $K \longrightarrow \infty$?

$$Y(K+2) - (3/4)\,Y(K+1) + (1/8)\,Y(K) = e(K)$$

Where; e(K) = 1 for K = 0,1,2,..(unit step)

Y(0) = y(1) = 0 **(10 marks)**

Question no.2 B-2

a) For the unity feedback discrete-data system shown in fig.1 ;
Determine the steady-state error when the system is subjected to
   i. A unit step input
   ii. A unit ramp input

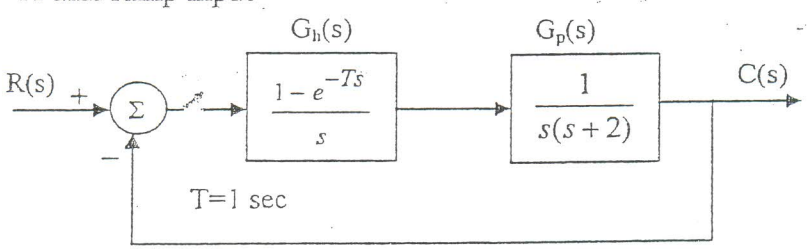

Fig.1

b) Determine, using Routh criteria the stability of the discrete-time system given by its characteristic equation.

$$z^3 + 5z^2 + 3z + 2 = 0 \qquad \textbf{(10 marks)}$$

Members of Course Examination Committee:		Signature:	Date:
Lecturer:	Medhat El Singaby	M. El Singaby	5/1/2015
Course Coordinator:	Ahmed EL-Shewy		5/1/2015
Head of Department:	Prof. Hamdy Ashour	Hamdy	5/1/2015

APPENDIX A. TABLE OF LAPLACE TRANSFORMS, z-TRANSFORMS AND MODIFIED z-TRANSFORMS

Laplace Transform F(s)	Time Function f(t) $t>0$	z-Transform F(z)	Modified z-Transform F(z,m)
1	$\delta(t)$	1	0
e^{-kTs}	$\delta(t-kT)$	z^{-k}	z^{-k-1+m}
$\frac{1}{s}$	$u_s(t)$	$\frac{z}{z-1}$	$\frac{1}{z-1}$
$\frac{1}{s^2}$	t	$\frac{Tz}{(z-1)^2}$	$\frac{mT}{z-1}+\frac{T}{(z-1)^2}$
$\frac{2}{s^3}$	t^2	$\frac{T^2z(z+1)}{(z-1)^3}$	$T^2\frac{m^2z^2+(2m-2m^2+1)z+(m-1)^2}{(z-1)^3}$
$\frac{(k-1)!}{s^k}$	t^{k-1}	$\lim_{a\to 0}(-1)^{k-1}\frac{\partial^{k-1}}{\partial a^{k-1}}\left[\frac{z}{z-e^{-aT}}\right]$	$\lim_{a\to 0}(-1)^{k-1}\frac{\partial^{k-1}}{\partial a^{k-1}}\left[\frac{e^{-amT}}{z-e^{-aT}}\right]$
$\frac{1}{s+a}$	e^{-at}	$\frac{z}{z-e^{-aT}}$	$\frac{e^{-amT}}{z-e^{-aT}}$
$\frac{1}{(s+a)^2}$	te^{-at}	$\frac{Tze^{-aT}}{(z-e^{-aT})^2}$	$\frac{Te^{-amT}[e^{-aT}+m(z-e^{-aT})]}{(z-e^{-aT})^2}$
$\frac{(k-1)!}{(s+a)^k}$	t^ke^{-at}	$(-1)^k\frac{\partial^k}{\partial a^k}\frac{z}{z-e^{-aT}}$	$(-1)^k\frac{\partial^k}{\partial a^k}\left[\frac{e^{-amT}}{z-e^{-aT}}\right]$
$\frac{a}{s(s+a)}$	$1-e^{-at}$	$\frac{z(1-e^{-aT})}{(z-1)(z-e^{-aT})}$	$\frac{(1-e^{-amT})z+(e^{-amT}-e^{-aT})}{(z-1)(z-e^{-aT})}$

Laplace Transform F(s)	Time Function f(t) $t>0$	z-Transform F(z)	Modified z-Transform F(z,m)
$\frac{1}{(s+a)(s+b)}$	$\frac{1}{(b-a)}(e^{-at}-e^{-bt})$	$\frac{1}{(b-a)}\left[\frac{z}{z-e^{-aT}}-\frac{z}{z-e^{-bT}}\right]$	$\frac{1}{(b-a)}\left[\frac{e^{-amT}}{z-e^{-aT}}-\frac{e^{-bmT}}{z-e^{-bT}}\right]$
$\frac{a}{s^2(s+a)}$	$t-\frac{1}{a}(1-e^{-at})$	$\frac{Tz}{(z-1)^2}-\frac{(1-e^{-aT})z}{a(z-1)(z-e^{-aT})}$	$\frac{T}{(z-1)^2}+\frac{amT-1}{a(z-1)}+\frac{e^{-amT}}{a(z-e^{-aT})}$
$\frac{1}{(s+a)^2}$	te^{-at}	$\frac{Tze^{-aT}}{(z-e^{-aT})^2}$	$\frac{Te^{-amT}[e^{-aT}+m(z-e^{-aT})]}{(z-e^{-aT})^2}$
$\frac{a}{s^3(s+a)}$	$\frac{1}{2}(t^2-\frac{2}{a}t+\frac{2}{a^2}u_s(t)-\frac{2}{a^2}e^{-at})$	$\frac{T^2z}{(z-1)^3}+\frac{(aT-2)Tz}{2a(z-1)^2}+\frac{z}{a^2(z-1)}-\frac{z}{a^2(z-e^{-aT})}$	$\frac{T^2}{(z-1)^3}+\frac{T^2(m+\frac{1}{2})a-T}{a(z-1)^2}+\frac{(amT)^2/2-amT+1}{a^2(z-1)}-\frac{e^{-amT}}{a^2(z-e^{-aT})}$
$\frac{a^2}{s(s+a)^2}$	$u_s(t)-(1+at)e^{-at}$	$\frac{z}{z-1}-\frac{z}{z-e^{-aT}}-\frac{aTe^{-aT}z}{(z-e^{-aT})^2}$	$\frac{1}{z-1}-\left[\frac{1+amT}{z-e^{-aT}}+\frac{aTe^{-aT}}{(z-e^{-aT})^2}\right]e^{-amT}$
$\frac{a^2}{s^2(s+a)^2}$	$t-\frac{2}{a}u_s(t)+(t+\frac{2}{a})e^{-at}$	$\frac{1}{a}\left[\frac{(aT+2)z}{(z-1)^2}-\frac{2z^2}{z-e^{-aT}}+\frac{2z}{z-e^{-aT}}+\frac{aTe^{-aT}z}{(z-e^{-aT})^2}\right]$	$\frac{1}{a}\left\{\frac{aT}{(z-1)^2}+\frac{amT-2}{z-1}+\left[\frac{aTe^{-aT}}{(z-e^{-aT})^2}-\frac{amT-2}{z-e^{-aT}}\right]e^{-amT}\right\}$
$\frac{\omega}{s^2+\omega^2}$	$\sin\omega t$	$z\sin\omega T$	$\frac{\sin m\omega T+\sin(1-m)\omega T}{z^2-2z\cos\omega T+1}$