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C – 2614

Reg. No. : ....

Name : ....

First Semester M.Tech. Degree Examination, June 2017
(2013 Scheme)
Branch : Electrical and Electronics Engineering
Streams : Control Systems, Guidance and Navigational Control
ECC1002 : DIGITAL CONTROL SYSTEMS

Time : 3 Hours　　　　　　　　　　　　　　　　　　　　　　Max. Marks : 60

Instruction : *Answer* ***any two*** *full questions from* ***each*** *Module.* ***Each*** *full question carries* ***10*** *marks.*

MODULE – I

1. a) State and prove the following theorems. Initial value theorem, final value theorem and complex translational theorem.

   b) Obtain the unit step response of the system given by $T(z) = \dfrac{(5z+6)(z-2)}{z^2 + \frac{3}{2}z + \frac{1}{2}}$.

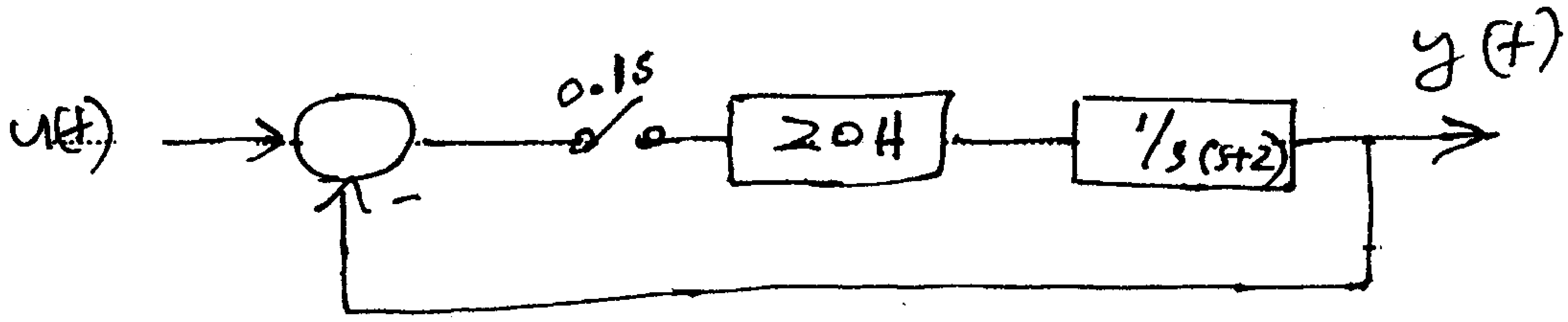
2. a) State and explain bilinear transformations.

   b) For each of the following analog controller, find the transfer fn. of the corresponding digital controller using pole-zero matching method.

   1) $G_1(s) = \dfrac{s}{s^2 + 2s + 4}$ T = 0.01

   2) $G_2(s) = \dfrac{10}{s^2 + 5s + 6}$ T = 0.1

3. a) Find the pulse transfer function of the following system.



   b) Examine the stability of the system with characteristic equations

   $G(z) = z^4 - 1.2z^3 + 0.08z^2 + 0.32z - 0.01 = 0.$

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MODULE – II

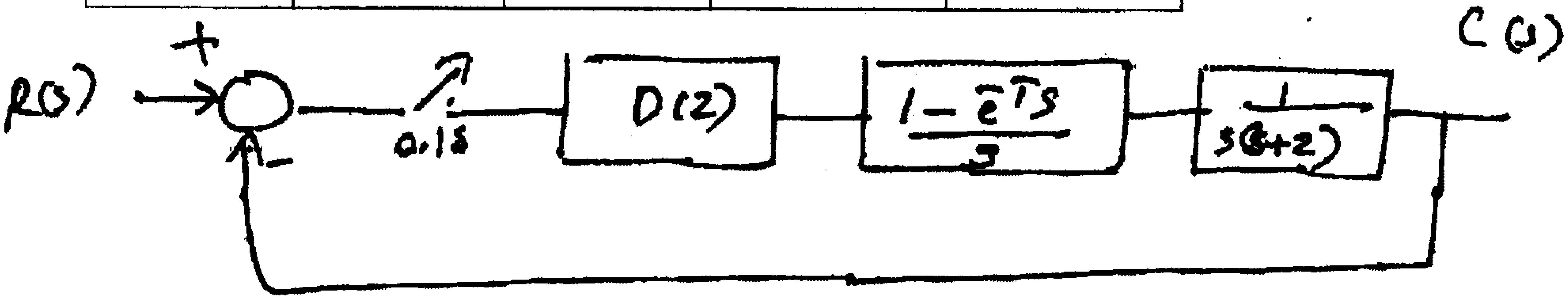
4. Design a digital controller such that the dominant closed loop poles have a damping ratio of 0.6 and settling time is 0.3 sec, sampling period T = 0.01s.

$G(s) = \dfrac{1}{s(s+4)}$ and $ZOH = \left(\dfrac{1-e^{-Ts}}{s}\right)$. Also find the acceleration error constant.

5. The frequency response of the system below is given in Table 1.

Table 1. Frequency response

ω_w	ω	$\lvert G(j\omega_w)\rvert$	$\lvert G(j\omega_w)\rvert_{dB}$	$\angle G(j\omega_w)$
0.10	0.099	9.95473	19.96	-98.530
0.20	0.199	4.91192	13.82	-106.980
0.30	0.297	3.20693	10.12	-115.100
0.40	0.394	2.34103	7.38	-122.830
0.50	0.490	1.81474	5.17	-130.100
0.60	0.582	1.46124	3.29	-136.870
0.70	0.673	1.20853	1.64	-143.140
0.80	0.761	1.02011	0.17	-148.920
0.90	0.845	0.8753	-1.15	-154.240
1.00	0.927	0.7614	-2.36	-159.130
2.00	1.570	0.30058	-10.44	-190.880
3.00	1.965	0.1822	-14.78	-205.370
4.00	2.214	0.13244	-17.55	-212.260
5.00	2.380	0.10579	-19.51	-215.430
6.00	2.498	0.08942	-20.97	-216.610
7.00	2.585	0.07849	-22.10	-216.680
8.00	2.651	0.07073	-23.00	-216.110
9.00	2.704	0.06502	-23.73	-215.180
10.00	2.746	0.06068	-24.33	-214.060
20.00	2.942	0.04455	-27.02	-203.020
30.00	3.008	0.04097	-27.75	-196.540
40.00	3.041	0.03964	-28.03	-192.770



i) Find the phase margin of the system when D(z) = 1.

ii) Design a controller D(z) = K such that the system phase margin is 50°.

iii) Design a unity dc gain phase-lag compensator that yields a phase margin of 50°.

6. a) Define observability and derive the rank list condition for complete state observability.

b) Obtain a state space representation of the following system in the diagonal canonical form $\frac{y(z)}{u(z)} = \frac{z^{-1} + 2z^{-2}}{1 + 0.7z^{-1} + 0.12z^{-2}}$.

MODULE – III

7. a) Explain the principle of duality in discrete time control systems.

b) Consider the following discrete time system in state space.

$$\begin{bmatrix} x_1(k+1) \\ x_2(k+1) \end{bmatrix} = \begin{bmatrix} 4 & -2 \\ 0 & 1 \end{bmatrix} \begin{bmatrix} x_1 & (k) \\ x_2 & (k) \end{bmatrix} + \begin{bmatrix} 2 \\ 1 \end{bmatrix} u(k)$$

Use state feedback to relocate the system poles to 0.50 and 0.20.

8. For the open loop system

$$G(z) = \frac{y(z)}{u(z)} = \frac{0.1185(z + 0.9669)}{z^2 - 1.6718z + 0.9048}$$

Find the control feedback 'k' and estimates gain 'ke' that will place control poles at $z = 0.8 \pm j\,0.2$ and estimator poles at $z = 0.6 \pm j\,0.3$. Determine what steady state value of y(k) would be if there was an input disturbance 'w'.

9. Design a full order state observer for the plant

$$\begin{bmatrix} \dot{x}_1 & (k+1) \\ \dot{x}_2 & (k+1) \\ \dot{x}_3 & (k+1) \end{bmatrix} = \begin{bmatrix} 4 & -1 & 2 \\ 0 & 1 & 4 \\ 0 & -4 & 0 \end{bmatrix} \begin{bmatrix} x_1 & (k) \\ x_2 & (k) \\ x_3 & (k) \end{bmatrix} + \begin{bmatrix} 4 \\ 1 \\ 0 \end{bmatrix} u(k)$$

$$y(k) = [1\ 0\ 1] \begin{bmatrix} x_1 & (k) \\ x_2 & (k) \\ x_3 & (k) \end{bmatrix} + u(k)$$

Choosing observer poles located at 0.2, $-0.5 \pm j\,0.5$.