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MANIPAL INSTITUTE OF TECHNOLOGY
MANIPAL
A Constituent Institution of Manipal University

SEVENTH SEMESTER B.TECH. (INSTRUMENTATION AND CONTROL ENGG.)

END SEMESTER EXAMINATIONS, DEC - 2017

SUBJECT: DIGITAL CONTROL SYSTEMS [ICE 4102]

Duration: 3 Hour Max. Marks:50

Instructions to Candidates:

- Answer **ALL** the questions.
- Missing data may be suitably assumed.

1A State Sampling theorem. With necessary frequency responses, illustrate sampling theorem. 4

1B Obtain the expression for Y(z) for the system shown in Fig. Q1B considering the input as unit step function.

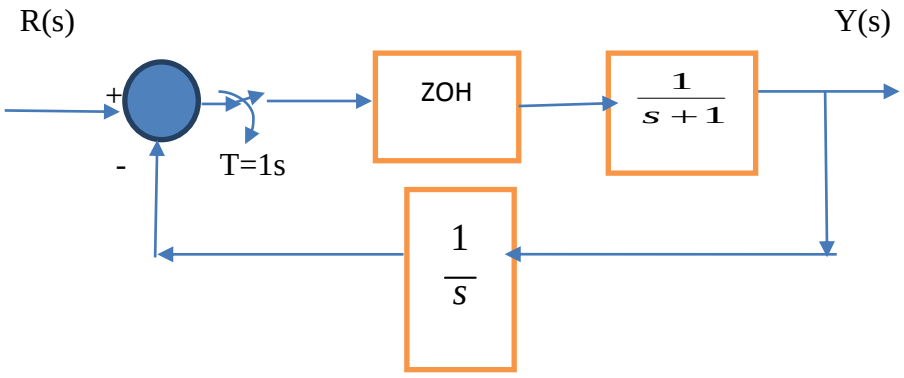

Fig. Q1B 6

2A Explain the transformation necessary to use the Routh stability test for determining stability of discrete time systems. 2

2B Given the characteristic equation of a discrete time system

$F(z)=z^4+0.6z^3-0.25z^2-0.2z-0.05=0$.

Determine its stability using Jury's stability test. 4

2C Show that steady state error of a unity feed back discrete time system depends on reference input signal R(z) as well as the forward path transfer function $G(z)=G_{ho}G_p(z)$, where G_{ho} represents the 4

ZOH. Hence find i) Steady state error due to step input

ii)Steady state error due to Ramp input

iii) Steady state error due to Parabolic input.

3A Obtain the pulse transfer function and response of the system described by the difference equation y[n]-0.6y[n-1]-0.16y[n-2]=5x[n], with y(-1)=y(-2)=0 and with x[n]=δ[n]. 3

3B Realise the following pulse transfer function in ladder form

$G(z)= \frac{z^2+2z+1}{z^2+8z-1}$ 3

3C Obtain the pulse transfer function of a digital PID controller in positional form. 4

4A Explain the procedure for designing a discrete time PD controller using root locus approach. 3

4B Consider a unity feedback discrete time system having forward path with a ZOH and a continuous plant $G_p(s)= \frac{1}{s(s+1)}$. Design a digital lead compensator D(z) for the system to meet the following specifications:

i) The velocity error constant K_v=7.5/sec.
ii) The peak overshoot M_p to step input is ≤15%
iii) Settling time T_s(2%tolerance band) ≤5 sec

Use Root locus method. Consider the sampling time as T=1sec 7

5A Consider the forward path of a unity feedback discrete time system having a ZOH and a continuous plant $G_p(s)= \frac{1}{s(s+1)}$. Determine its W-transfer function. Compare it with continuous plant transfer function and comment on observations. Let the sampling time be T=1s. 3

5B Bode plot of W transformed function with steady state gain adjustment is shown in Fig. Q5B vs. fictitious frequency γ. From the plot design a phase lag compensator to achieve a desired phase margin of 40^0. Hence derive the pulse transfer function of the controller and represent it in the difference equation form. Assume a sampling time of T=1sec. 7

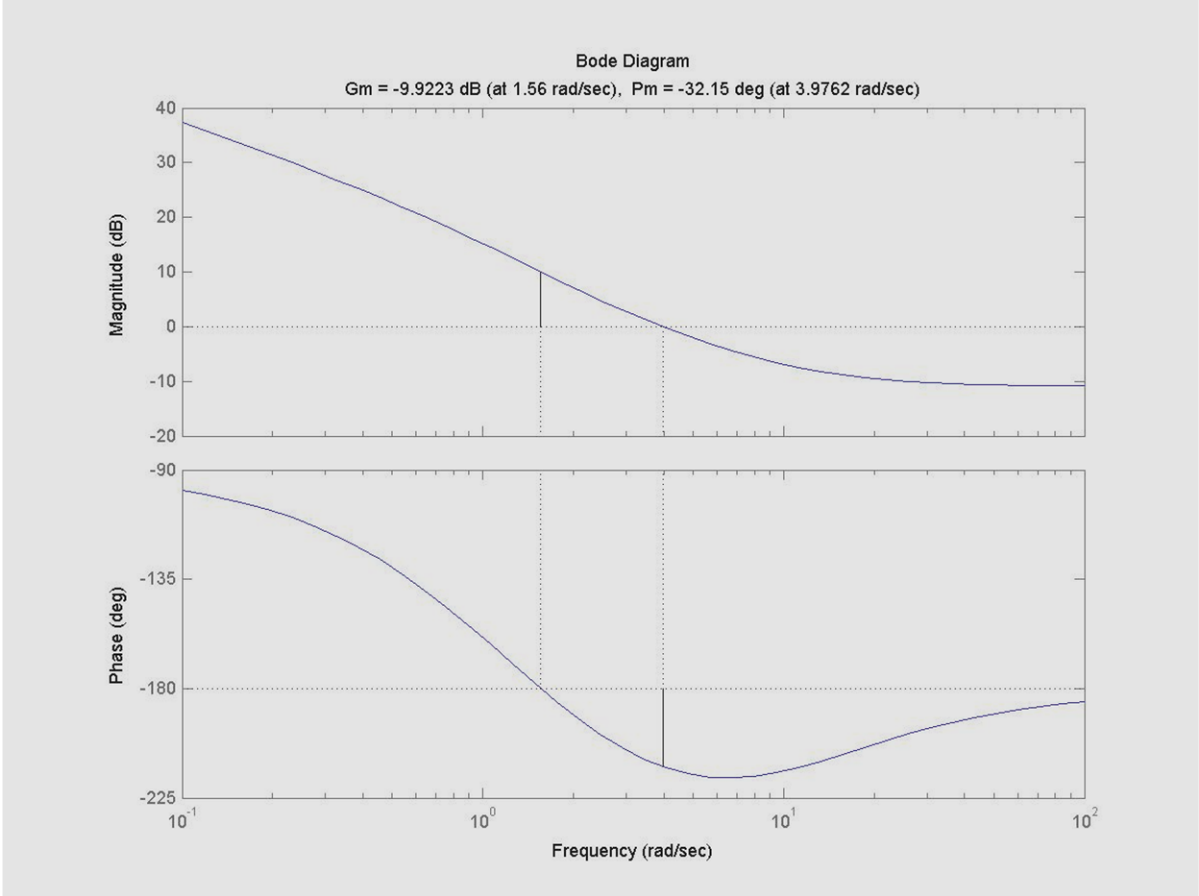
Bode Diagram
Gm = -9.9223 dB (at 1.56 rad/sec), Pm = -32.15 deg (at 3.9762 rad/sec)
Magnitude (dB)
40
30
20
10
0
-10
-20
Phase (deg)
-90
-135
-180
-225
10^-1
10^0
10^1
10^2
Frequency (rad/sec)

Fig. Q5B