University of Mumbai

Examination 2020 under cluster __(Lead College: _____)

Examinations Commencing from 23rd December 2020 to 6th January 2021 and from 7th January 2021 to 20th January 2021

Program: **Instrumentation**

Curriculum Scheme: Rev 2016

Examination: BE Semester VII

Course Code: ISDLO 7032 and Course Name: Digital Control System

Time: 2 hour Max. Marks: 80

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NOTE to the Question Paper Setter: (To be deleted before submitting the paper to Semester Coordinator)

1. *The question paper will be of total **80 Marks and Two hours duration**. Out of which **40 marks will be of 20 MCQs** carrying two marks each covering all the modules of the syllabus. Remaining two questions carrying 20 marks each (Total **40 marks) will be of subjective/descriptive in nature** of 5 or 10 marks as per the requirement of the subject/course and covering all the modules of the syllabus.*
2. *Referring to setting up MCQs*
    a. *You need to check the questions and their answers for their correctness. There should not be any ambiguity in the questions and the options. Only one option should be the Correct Answer.*
    b. *Among **20MCQs** (based on complete syllabus), 8 questions can be under the 'Simple' category, 6questions can be under the 'Moderate' category, and the remaining 6questions can be under the 'Difficult' category.*
    c. *Please do not reveal answer on this Question Paper.*
    d. *Use another template provided to enter the correct answers.*
3. *Referring to setting up subjective/descriptive questions*
    a. *Internal options should be provided in the subjective questions i.e. in case of 5 marks question 3 or 6 questions to be asked, out of which students will solve any two or four respectively. In case of 10 marks questions, 2 or 3 questions to be asked out of which students will solve any one or two respectively.*
    b. *The sub questions in Q2 and Q3 have to be set on multiple modules. The paper setter has to make sure that the maximum syllabus is covered while setting up the questions for Q2 and Q3.*
    c. *Weightage of the questions has to be decided as per the requirement of the subject. 10 marks questions will only be asked on design orientated subjects or application orientated subjects.*
    d. *Paper setters shall select any one option, while setting up the questions, suggested in the template for Q2 and Q3*
4. *Please save this file with file nameas per the sample format given below:*

    File Name: "Date of Examination_Scheme_Program_Semester_Subject Code_QP Set Number"

    For example:

    QP set number 1 of Engineering Mathematics-I of First Year Semester I for Rev2019 scheme and scheduled on 7/01/2021 has to have the file name as

    0701_R19_FE_I_FEC101_QP1

    QP set number 1 of first core course of Mechanical Engineering Semester V for Rev2016 scheme and scheduled on 23/12/2020 has to have the file name as

    2312_R16_Mech_V_MEC501_QP1

    QP set number 3 of Department Level Optional Course of Computer Engineering Semester VI for Rev2012 scheme and scheduled on 3/01/2021 has to have the file name as

    0301_R12_Comp_VI_CSDLO6021_QP3

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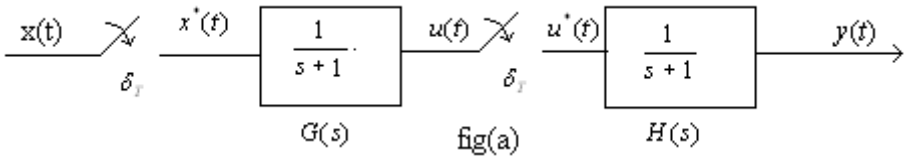
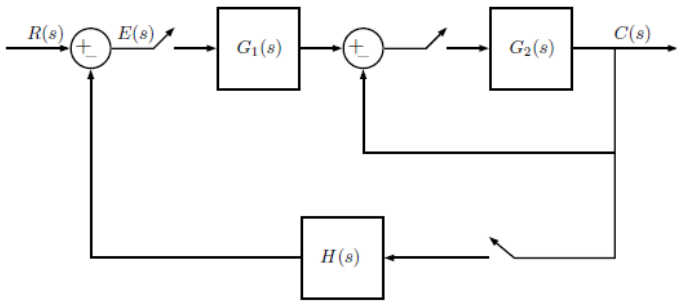
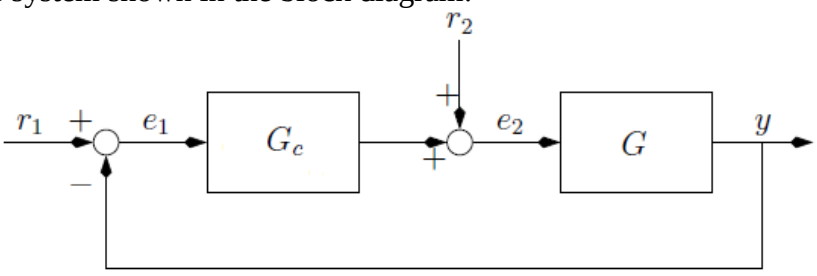
Q1.	**Choose the correct option for following questions. All the Questions are compulsory and carry equal marks**
1.	Which of the following is not a method of discretization
Option A:	Bilinear Transformation
Option B:	Z transform
Option C:	Euler Approximation
Option D:	Impulse Invariance method
2.	Sampling theorem for reconstruction of the signal states that
Option A:	Sampling frequency should be greater than twice the highest frequency component present in the continuous-time signal.
Option B:	Sampling frequency should be less than the highest frequency component present in the continuous-time signal.
Option C:	Sampling frequency and highest frequency component present in the continuous-time signal should be the same.
Option D:	Sampling frequency should be greater than half of the highest frequency component present in the continuous-time signal.
3.	The plant represented by transfer function $G(S)=\frac{1}{s+1}$ is preceded by a Zero order hold block. What is the transfer function of the equivalent transfer function? Assume sampling time to be 0.5 sec.
Option A:	$\frac{0.606}{z-0.93}$
Option B:	$\frac{0.606}{z-0.393}$
Option C:	$\frac{0.606}{z-0.606}$
Option D:	$\frac{0.393}{z-0.606}$
4.	A Discrete time system is represented by state space model $x(k+1) = e^{aT} x(k) + \frac{e^{aT}-1}{a} u(k)$, $y(k) = x(k)$ Find the pulse transfer function for the system
Option A:	$e^{-aT}/(1-z^{-1})$
Option B:	$\frac{(1-e^{-aT})}{a(Z-e^{-aT})}$
Option C:	$\frac{(e^{aT}-1)}{a(Z-e^{aT})}$

Option D:	$\frac{(1-e^{aT})}{a(Z-e^{aT})}$
5.	The sample can be considered as impulse modulator wherein
Option A:	carrier is train of unit impulses
Option B:	carrier is unit amplitude square wave
Option C:	carrier is unit amplitude sine wave
Option D:	a carrier can be any periodic signal.
6.	Constant attenuation locus in *s*-plane is mapped in *z*-plane as
Option A:	circle
Option B:	radial line passing through origin.
Option C:	spiral
Option D:	line parallel to the imaginary axis.
7.	Find the transfer function of the system given in figure (a) . Assume sampling time as  fig(a)
Option A:	$\frac{z^2}{(z-0.632)^2}$
Option B:	$\frac{z^2}{(z-1)^2}$
Option C:	$\frac{z^2}{(z-0.367)^2}$
Option D:	$\frac{z^2}{(z-0.367)(z-0.632)}$
8.	Integration of the continuous-time function is represented in discrete-time domain as
Option A:	product of sampled values of the function.
Option B:	ratio of successive sampled values of the function.
Option C:	summation of sampled values of the function.
Option D:	difference in successive sampled values of the function.
9.	No sign changes in the first column of RH table indicates
Option A:	System is conditionally stable
Option B:	System is marginally stable
Option C:	zeros in the unstable region
Option D:	poles in the system in the unstable region
10.	If T is the sampling period then Z-transform of the function $(1-e^{Ts})G(s)/s$ is

	given by
Option A:	$(1-z^{-1})Z\{G(s)/s\}$
Option B:	$(1-T^{-1})Z\{G(s)/s\}$
Option C:	$(1-Tz^{-1})Z\{G(s)/T\}$
Option D:	$(1-T^{-1})Z\{G(s)/T\}$
11.	The stability of a 6th order system is being checked using Jury's Stability test. Which of the following conditions for characteristics equation F(z) are necessary for the system to be stable
Option A:	F(1)>0 and F(-1) >0
Option B:	F(1)>0 and F(-1) <0
Option C:	F(1)=0 and F(-1) >0
Option D:	F(1)<0 and F(-1) <0
12.	A system has a characteristics equation. $F(z)=z^2-0.25$. Which of the following conditions are true to test the stability of the system using Jury's Stability test
Option A:	The necessary conditions are not satisfied but the sufficient conditions are satisfied
Option B:	The necessary and sufficient conditions are not satisfied
Option C:	The necessary conditions are satisfied but the sufficient conditions are not satisfied
Option D:	The necessary and sufficient conditions are satisfied
13.	Which of the statement is true regarding the effect of sampling time on the steady state error
Option A:	Steady state error increase with increase in sampling time
Option B:	Steady state error decreases with increase in sampling time
Option C:	Steady state error increase exponentially with increase in sampling time
Option D:	Steady state error does not change with change in sampling time
14.	A second order system is described by the state matrix $G=\begin{bmatrix}0.5 & 1\\ 1 & -0.5\end{bmatrix}$ The state transition matrix of the system is
Option A:	$\begin{bmatrix}0.5^k & 1\\ 1 & -0.5^k\end{bmatrix}$
Option B:	$\begin{bmatrix}0.5^k & 0\\ 0 & -0.5^k\end{bmatrix}$
Option C:	$\begin{bmatrix}1 & 0.5^k\\ -0.5^k & 1\end{bmatrix}$
Option D:	$\begin{bmatrix}0 & 0.5^k\\ -0.5^k & 0\end{bmatrix}$
15.	A 3rd order system is represented in controllable canonical form. What can you

	comment about the state model
Option A:	Controllable but not observable
Option B:	Observable but not controllable
Option C:	Cannot be determined
Option D:	Controllable and observable
16.	A 5^{th} order system is represented in parallel form. Which of the statement is true for the structure of the system
Option A:	Structure of the system comprises of 3 first order blocks and a second order block in parallel
Option B:	Structure of the system comprises of 5 first order block in parallel
Option C:	Structure of the system comprises of 3 first order blocks in parallel cascaded with a second order block
Option D:	Parallel combination of a 3^{rd} order and 2^{nd} order blocks
17.	A property that characterizes our ability to determine the states of the system from input and output is called
Option A:	Controllability
Option B:	Observability
Option C:	Differentiability
Option D:	Adaptability
18.	In MROF
Option A:	control input are sampled at different rates.
Option B:	sensor outputs of a system are sampled at same rates.
Option C:	control input and sensor output of a system are sampled at different rates.
Option D:	control input and sensor output of a system are sampled at same rates.
19.	The principle approach of internal model control is _____
Option A:	To eliminate disturbance entering the process
Option B:	To perform regulatory control action to reduce error
Option C:	To simulate the response of the system in order to estimate the outcome of a system disturbance.
Option D:	To generate control signal for final control element
20.	Type of a system means
Option A:	Total number of poles in a system
Option B:	Number of zero at Z=1
Option C:	Total number of zeros in a system
Option D:	Number of poles at Z=1

Q2	**Solve any four Questions out of six 05 marks each**
A	The stability of the discrete time system with characteristic equation $F(z)=z^3-1.25z^2-1.375z-0.25=0$ is analyzed using Routh Hurwitz (RH) criteria. How many sign changes are there in the first column of the RH table?
B	Obtain the pulse transfer function for the system described by the discrete time state model

	$$x(k+1)=\begin{bmatrix}1 & -2\\ 2 & -1\end{bmatrix}x(k)+\begin{bmatrix}0\\ 1\end{bmatrix}u(k)$$ $$y(k)=\begin{bmatrix}1 & 0\end{bmatrix}\begin{bmatrix}x_1(k)\\ x_2(k)\end{bmatrix}$$
C	An analog compensator for a certain system is $$D(s)=\frac{s+1}{0.5s+1}$$. Obtain the corresponding digital transfer function using bilinear transformation if sampling rate for the system is $w_s=\sqrt{3}$ rad/sec
D	Analyze the controllability of the system described by $$x(k+1)=\begin{bmatrix}1 & 1\\ 0 & 1\end{bmatrix}x(k)+Bu(k)$$ where (i) B=[1 0]^T and (ii) B=[0 1]^T
E	Explain the Mason's gain formula to obtain transfer function from a signal flow graph. Find the pulse transfer function of the following system using sampled signal flow graph approach. 
F	For the system shown in the block diagram:  Determine the internal stability if $G=\frac{2.8(z-0.3)}{z-0.1298}$ and $G_c=\frac{z-1.03}{z-1}$.

Q3	**Solve any Two Questions out of Three 10 marks each**
A	Derive the state space model in controllable canonical form for the following system represented by

	$\frac{Z+8}{Z^2+3Z+6}$
B	A discrete time system is given by x (k+1) = G x(k) + H u(k). where G = $\begin{bmatrix} 0 & 2 \\ -1 & -2 \end{bmatrix}$ H=$\begin{bmatrix} 1 \\ -1 \end{bmatrix}$ Determine feedback gain matrix k such that system will have the closed loop poles at z=0.5±j0.3
C	Define static position, velocity and acceleration error coefficient for a discrete time LTI system and find the steady state error for step, ramp and parabolic input for a unity feedback system characterized by the open loop transfer function $G_{h0}G(z) = \frac{0.5(z+1)}{(z-1)(z-0.5)(z-0.9)}$ The sampling period is T=0.1 sec.