Reg. No.									

MANIPAL INSTITUTE OF TECHNOLOGY
MANIPAL
(A constituent unit of MAHE, Manipal)

SECOND SEMESTER M.TECH. (AVIONICS)
END SEMESTER EXAMINATIONS, MAY 2024

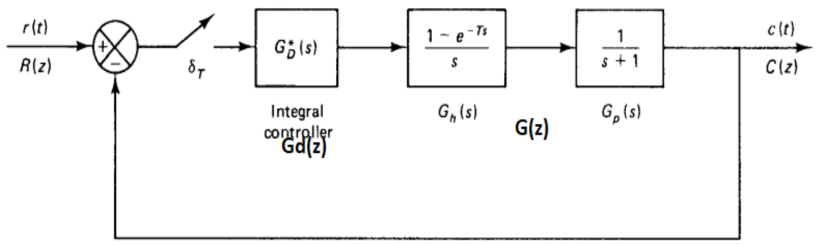
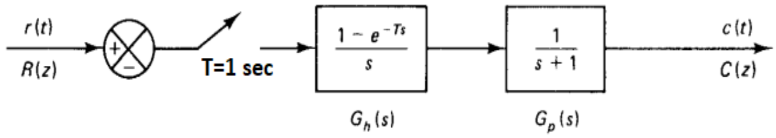
DIGITAL CONTROL SYSTEMS [AAE 5433]

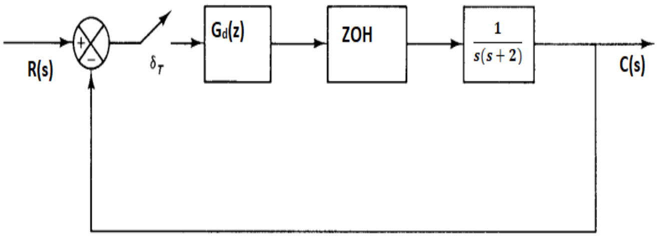
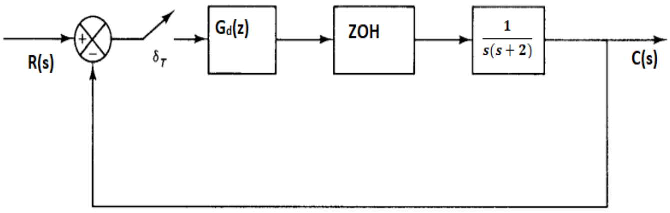
REVISED CREDIT SYSTEM

Time: 3 Hours **Date: 07 May 2024** **Max. Marks: 50**

Instructions to Candidates:

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

Q.NO	Questions	Marks	CO	BTL
1A.	Solve and obtain the initial value and final value of the function $f(z) = \frac{z^2+2z+1}{z^3+3z^2+3z+1}$	**(03)**	**1**	**3**
1B.	Determine the inverse Z transform of the function $X(z) = \frac{z+1}{(z+2)(z+3)}$	**(02)**	**1**	**3**
1C.	Given the feed-forward pulse transfer function (open loop pulse transfer function) of a digital control system $G_d(z)G(z) = \frac{Kz(1-e^{-T})}{(z-1)(z-e^{-T})}$, with sampling period, T=0.5 sec.  **Fig. Q1C** i.Determine the poles, zeros, break in and breakaway points of the system ii. Plot the root locus of the system	**(05)**	**3**	**4**
2A.	Evaluate the pulse transfer function and step response of the following system if $G_p(s) = \frac{1}{s+1}$.  **Fig.Q2A**	**(03)**	**2**	**3**

2B.	For a system with characteristic equation $z^2 + z(0.2838K-1.1353] + 0.1353+ 0.1485K = 0$, determine the range of K for stability using bilinear transformation.	***(03)***	***3***	***4***
2C.	Analyze the stability of the system with characteristic equation $P(z) = z^3-1.1z^2 -0.1z+0.2 = 0$, using Jury's stability test.	***(04)***	***3***	***4***
3A.	For the digital control system with a lag compensator such that the compensated system satisfies the following specifications: damping ratio, ζ = 0.517; settling time, t_s = 5 sec; sampling period, T =0.52 sec; static velocity error constant of the compensated system, K_v= 6 sec^{-1}. The pulse transfer function of the uncompensated system is $G_{ho}G_p(z)= \frac{0.098(z+0.714)K}{(z-1)(z-0.353)}$. i. Develop the transient specifications ii. Determine the dominant closed loop poles  **Fig.Q3A**	***(03)***	***4***	***3***
3B.	For the digital control system with a lag compensator such that the compensated system satisfies the following specifications: damping ratio, ζ = 0.517; settling time, t_s = 5 sec; sampling period, T =0.52 sec; static velocity error constant of the compensated system, K_v= 6 sec^{-1}. The pulse transfer function of the uncompensated system is $G_{ho}G_p(z)= \frac{0.098(z+0.714)K}{(z-1)(z-0.353)}$. Determine the pulse transfer function compensated system and thus design the controller.  **Fig.Q3B**	***(04)***	***4***	***6***
3C.	Design a digital PID controller using root locus approach for a DC motor speed control system , where the pulse transfer function of the plant is $G_{ho}G_p(z)= \frac{1.2417 X 10^{-5}(z+0.9934)}{(z-0.995)(z-.9851)}$ for a time constant of 0.3 second, a dominant pole damping ratio of 0.7, sampling period T= 0.005 sec.	***(03)***	***4***	***6***
4A.	The vertical and horizontal dynamics of an autonomous underwater vehicle must be controlled to remotely operate	***(05)***	***5***	***4***

	the vehicle. The difference equation of the horizontal motion of the vehicle is given by $y(k+2) + 5y(k+1) + 6y(k) = u(k)$ i) Develop the discrete state model of the motion of the vehicle ii) For the input $u(k) = 1$, $k \geq 1$, Solve output $y(k)$. Where $y(0)=0, y(1)=0$, T= 1 sec			
4B.	Analyse the controllability and observability of a computer control system with the given state space model. $x(k+1) = \begin{bmatrix} -2 & 1 \\ 1 & -2 \end{bmatrix} x(k) + \begin{bmatrix} 1 \\ 1 \end{bmatrix} u(k)$ $y(k) = [1 \quad 1]x(k)$	**(03)**	**5**	**4**
4C.	Given $E(s) = \frac{10(s+2)}{s^2(s^2+2s+3)}$. Apply sampling theorem and determine the maximum value of the sampling interval T that can be used to reconstruct e(t) from its samples.	**(02)**	**2**	**3**
5A.	Apply logarithmic transformation and solve the given nonlinear difference equation $[y(k+2)][y(k+1)]^5[y(k)]^4 = u(k)$, which describes a non linear discrete time control system with zero initial conditions and the input $u(k)= e^{-10k}$	**(02)**	**5**	**3**
5B.	Summarize on the software requirements, selection of ADC and DAC, sampling period switching with respect to the design of hardware and software architecture of digital control system	**(05)**	**5**	**2**
5C.	Explain the computer control of an aircraft turbojet engine with the help of block diagram.	**(03)**	**5**	**2**