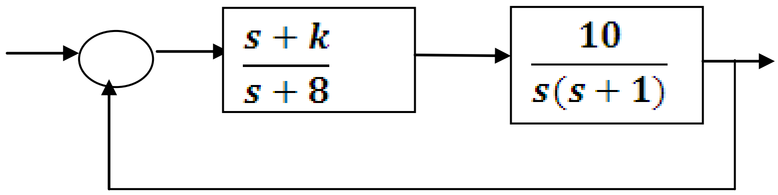
GUJARAT UNIVERSITY

BE Semester-VII (<u>Instrumentation & control</u>) Question Bank

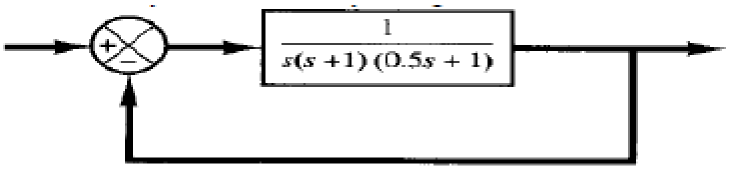
(CONTROL SYSTEM DESIGN) IC 701

All questions carry equal marks(10 marks)

Q.1	Explain properties of Z-transform with derivations.
Q.2	Obtain the time response of the following system : $$\begin{bmatrix}\dot{x}_1\\ \dot{x}_2\end{bmatrix} = \begin{bmatrix}0 & 1\\ -2 & -3\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix} + \begin{bmatrix}0\\ 1\end{bmatrix} u$$ Where u (t) is unit-step function occurring at t =0 or u (t) =1(t).
Q.3	What is the design procedure for lag compensation using root-Locus method?
Q.4	Consider the system given by, $$\begin{bmatrix}\dot{x}_1\\ \dot{x}_2\\ \dot{x}_3\end{bmatrix} = \begin{bmatrix}2 & 0 & 0\\ 0 & 2 & 0\\ 0 & 3 & 1\end{bmatrix}\begin{bmatrix}x_1\\ x_2\\ x_3\end{bmatrix} + \begin{bmatrix}0 & 1\\ 1 & 0\\ 0 & 1\end{bmatrix}\begin{bmatrix}u_1\\ u_2\end{bmatrix}$$ $$\begin{bmatrix}y_1\\ y_2\end{bmatrix} = \begin{bmatrix}1 & 0 & 0\\ 0 & 1 & 0\end{bmatrix}\begin{bmatrix}x_1\\ x_2\\ x_3\end{bmatrix}$$ Check the system controllability.
Q.5	Discuss the optimal control systems in detail with necessary equations and also brief about the procedure to find out feedback gain for the Systems.
Q.6	Find the z-transform and ROC of the signal X(n)=[7(2^n)-4(5^n)]u(n)
Q.7	Define controllability and observability in brief with the examples.
Q.8	A unity feedback control system has an open-loop transfer function of G(s) $=K/s^2$ .Design a lead compensator such that K_a =1 and PM≥45^o .
Q.9	Explain transformation of system model with MATLAB.
Q.10	Consider the system defined by $\dot{X}$ = AX +Bu ,y = Cx where $$A = \begin{bmatrix}-1 & 0 & 1\\ 1 & -2 & 0\\ 0 & 0 & -3\end{bmatrix}; B = \begin{bmatrix}0\\ 0\\ 1\end{bmatrix}; C = [\,1 \;\; 1 \;\; 0\,]$$ Obtain the transfer function Y(s) / U(s).
Q.11	Define state variable and state model. If a system has one input, one output and three states, find out the dimensions of the Various matrices of the state model.

Q.12	Consider the system defined by $\dot{X}$ = AX +Bu ,y = Cx where A = $\begin{bmatrix} -1 & 0 & 1 \\ 1 & -2 & 0 \\ 0 & 0 & -3 \end{bmatrix}$; B = $\begin{bmatrix} 0 \\ 1 \\ 1 \end{bmatrix}$;C = [1 1 1] Obtain the observable canonical form.
Q.13	What is compensation? What are the different types of compensation? Explain lead compensation network in detail.
Q.14	Obtain the time response of the system given below $\dot{X}$ = AX Where A= $\begin{bmatrix} 0 & -2 \\ 1 & 0 \end{bmatrix}$; given X(0) = $[1 \quad 1]^T$ and y = [1 -1] $\begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$
Q.15	Discuss the lead compensation technique based on frequency response (bode plot). List the necessary steps.
Q.16	Consider the system shown below, determine the value of k such that the damping ratio ξ of the dominant closed loop poles is 0.5. 
Q.17	Obtain the lead compensator for the type-1 unity feedback system with open loop transfer function, $G_f(s) = \frac{K}{s(s+1)}$. It is required to have $K_v = 12\ sec^{-1}$ and phase margin = 40° .
Q.18	Discuss the lag compensation technique based on frequency response (Bode plot). List the necessary steps.
Q.19	For the following transfer function, it is desired to compensate the system so as to meet the following specifications, $G(s) = \frac{1}{s^2}$; required specifications are settling time ≤ 4 seconds and peak overshoot ≤ 20%. Apply lead compensation to obtain desired specifications.
Q.20	Derive the transfer function of electronic lag-lead compensator using operational amplifiers.
Q.21	Prove that the system defined by $\dot{X}$ = AX and Y =CX is completely observable if and only if the composite mn × n matrix P, where

	$P = \begin{bmatrix} C \\ CA \\ . \\ . \\ CA^{n-1} \end{bmatrix}$ is of rank n.
Q.22	Draw the circuit diagram of a lag compensator and obtain its transfer function.
Q.23	Design a suitable compensator for the system whose open-loop transfer function is $G(s)H(s) = \frac{16}{s(s+4)}$ So that the velocity error constant k_v=20 sec^{-1} without changing the original poles.
Q.24	Obtain the time response of the following system : $\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} 1 & -5 \\ -2 & 4 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u$ Where u (t) is unit-step function occurring at t =0 or u (t) =1(t).
Q.25	For the unity negative feedback system having transfer function , $G(s) = \frac{4}{s(s+2)}$ It is desired to design a compensator for the system so that the static velocity error constant K_v is 20 sec^{-1}, the phase margin is at least 50°, and the gain margin is at least 10 dB.
Q.26	Draw the circuit diagram of a lead compensator and obtain its transfer function.
Q.27	The open loop transfer function of a system is G(s)= $\frac{3}{s(s+1)(0.5s+1)}$ Design a lag compensator such that PM≥45^{o}.
Q.28	What is compensation? What are the different types of compensation? Explain lead compensation network in detail.
Q.29	For the negative feedback system H(s)= 1 and $G(s) = \frac{1}{s(s+1)(0.5s+1)}$ It is desired to compensate the system so that Kv is 5 sec^{-1}, the phase margin is at least 40° and the gain margin is at least 10 dB. Use a lag compensator.
Q.30	Describe the advantage and disadvantage of lead and lag compensator.
Q.31	The open loop transfer function of dc motor is

	$\frac{k}{s(s+2)(s+4)}$ Design suitable compensator for damping ratio=0.5 and ω_n = 3 rad/sec.
Q.32	Find H(z) using impulse invariance method at 5 Hz sampling frequency from, $H(s) = \frac{2}{(s+1)(s+2)}$
Q.33	Consider the system as shown by the figure below:  Design a lag compensator so that the above system has phase margin of 40 degree and velocity error constant is Kv=5 sec-1.
Q.34	Determine the z transform for $f(t) = \sin(\omega t)$ and $f(t) = e^{-at}$.
Q.35	What is necessity of compensator in control system ? What is selection criterion of compensators ? Realise all three basic compensators electrically.
Q.36	Explain controllability and observability in detail with its suitable examples.
Q.37	Obtain the z transform of $X(s) = \frac{1-e^{-sT}}{s}\frac{1}{s+1}$. Where, *T* is the sampling interval.
Q.38	Check the controllability of the system given with state matrices As $A = \begin{bmatrix} 1 & 1 & 0 \\ 3 & 0 & 1 \\ -6 & 11 & 5 \end{bmatrix}, B = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix}, C = \begin{bmatrix} 1 & 9 & 2 \end{bmatrix}$
Q.39	Brief about controllability and observability in context of state space analysis. Also comment on state transition matrix. Draw the block diagram of open loop and closed loop systems in state space.
Q.40	Obtain the lead compensator for the type-1 unity feedback system with open loop transfer function, $G(s) = \frac{K}{s(s+3)(s+5)}$ It is required to have $K_v = 12\ sec^{-1}$ and phase margin = 40° .