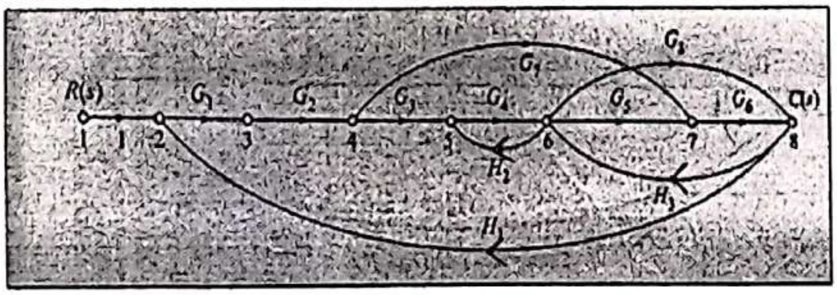
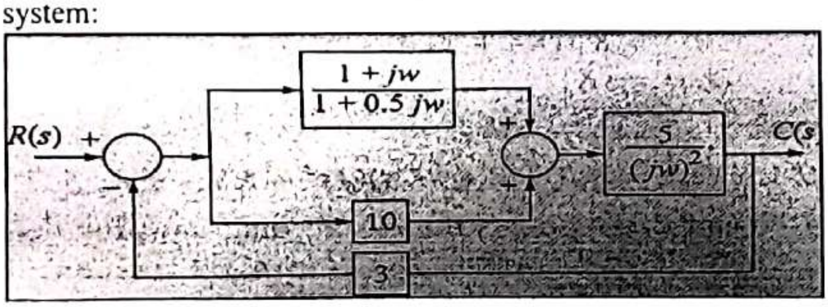
Punjab Engineering College (Deemed to be University)
Chandigarh
Mid-Term Examination (22231)

Programme: **B.Tech (ECE)**
Course Name: **Control Systems**
Maximum Marks: **25**

Year/Semester: **3rd/5th**
Course Code: **EC1352**
Time allowed: **1.5 Hours**

Notes

- All questions are compulsory.
- Unless stated otherwise, the symbols have their usual meanings in context with subject. Assume suitably and state, additional data required, if any.
- The candidates, before starting to write the solutions, should please check the question paper for any discrepancy, and also ensure that they have been delivered the question paper of right **course code**

Q. No			Marks
1	a)	Suppose you are required to design a control system representing a smart air conditioner. Out of open loop control system and closed loop control system, which type of control system would you select out and why?	2
	b)	Identify the organ-system components, and describe the operation of the biological control system consisting of a human being reaching for an object. Also draw the block diagram of system.	2
2	a)	Deduce transfer function C(s)/R(s) of the signal flow graph shown below: 	4
	b)	Solve to convert the following control system shown below into a unity feedback system: 	4

3	a)	Decide whether the servomechanism is stable for K=6, for its output c(t) which is related to its input r(t) by: $$[s^4+2s^3+2s^2+(K+3)s+K]\,C(s)=K(s+1)R(s)$$ where K is a positive gain. Also evaluate the limiting positive values of K for stability.	3
	b)	Predict the type of system, error coefficients and the steady state error of the unity feedback system having: $$G(s) = 5(s+1)/s^2(s+3)(s+10)$$ for the input $r(t) = 1+3t+(t^2/2)$.	3
	c)	Identify by what factor should the amplifier gain of unit step response of the unity feedback open loop system be reduced so that the peak overshoot is reduced from 75% to 25% : $$G(s)=K/s(Ts+1)$$ where K and T are positive constants.	3
	d)	Evaluate angle of asymptotes, breakaway points, if any, centroid and intersection point of root locus with imaginary axis for the open loop transfer function of a system expressed below: $$G(s)H(s)=K/s(s+6)$$	3
	e)	Measure the sensitivity of a unity feedback transfer function with $G(s) = K/s(s+a)$ to changes in the parameter 'a'. Explain how would you reduce the sensitivity?	1

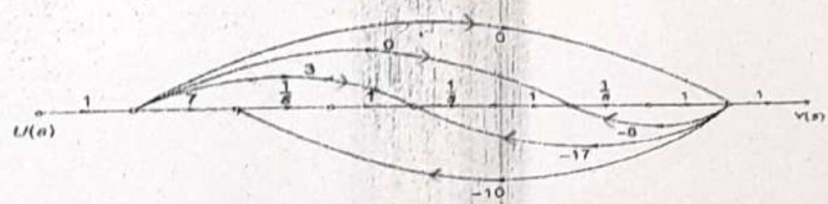
Punjab Engineering College (Deemed to be University)
Chandigarh
End-Term Examination (22231)

Programme: **B.Tech. (ECE)**
Course Name: Control Systems
Maximum Marks: 50

Year/Semester: **5th**
Course Code: **EC 1352**
Time allowed: **3 Hours**

Notes

- All questions are compulsory.
- Unless stated otherwise, the symbols have their usual meanings in context with subject. Assume suitably and state, additional data required, if any.
- The candidates, before starting to write the solutions, should please check the question paper for any discrepancy, and also ensure that they have been delivered the question paper of right **course code**

Q. No		Questions	Marks
1	a	In a nuclear power generating plant, heat from a reactor is used to generate steam for turbines. The rate of fission reaction determines the amount of heat generated and this rate is controlled by rods inserted into the radioactive core. The rods regulate the flow of neutrons. If the rods are lowered in to the core, the rate of fission will diminish, if the rods are raised, the fission rate will increase. By automating controlling the position of rods, the amount of heat generated by the reactor can be regulated. Draw a functional block diagram for the nuclear reactor control system.	2
	b	A continuous time linear time invariant system is represented by the signal flow graph given below. (a) Formulate the transfer function of the system by Mason's Gain formula. (b) Construct the state space representation of the system by defining the output of each integrator as a state variable. 	4
	c	Demonstrate the state space representation in phase variable form for the transfer function $\frac{C(s)}{R(s)} = \frac{s^3+5s^2+6s+1}{s^3+4s^2+3s+3}$	3
	d	State the advantages of state space approach over the classical design methods?	1

2 a Examine the time response of a second order system when the system is subjected to a unit step input given below: **4**

Time(s)	0	0.05	0.1	0.15	0.2	0.25	0.3	0.36	0.4	0.45	0.5
c(t)	0	0.25	0.8	1.12	1.02	0.98	0.98	1.0	1.0	1.0	1.0

Evaluate the frequency response parameters of the system: Resonant peak and resonant frequency.

b Consider a system whose loop transfer function is given by $G(s)H(s) = \frac{k}{s(s+1)}$. Construct the root locus. For designing a controller, following two modifications are done (i) an open loop pole is added at s = -3 (ii) an open loop zero is added at s = -3. Analyse the effect of doing these modifications individually on root locus. **7**

c A unity feedback system with $G(s) = \frac{K(s+\alpha)}{S((s+\beta))}$ is to be designed to meet the following requirements: The steady state error for unit ramp input equals 1/10; the closed loop poles will be located at -1±j1. Design the system by selecting the appropriate values of K, α, β in order to meet the specifications. **4**

3 a Describe the impact of PD (Proportional plus derivative) controller and PI (Proportional plus Integral) controller on system performance? Draw the block diagrams representing PD and PI control actions. Design a PD (Proportional plus derivative controller) for making the unity feedback system with undermentioned open loop transfer function critically damped **4**

$$G(s) = \frac{3}{s(s + 1.5)}$$

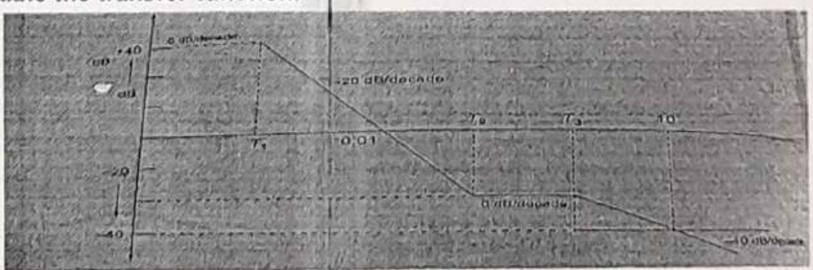
b An uncompensated system was compensated or improved by incorporating the following transfer function. State and evaluate the type of the network incorporated by sketching the gain and phase curves of the compensator. What is effect of using this compensator on system performance. Compare this compensator with other compensators that can be used to improve the performance of the system. **6**

$$G(s) = \frac{1 + s}{1 + 0.1s}$$

4 a For the unity feedback system with G(s) = K/[s(s+2)(s+10)], Examine the range of gain K for stability. Use the Nyquist criterion. **5**

b The experimental frequency response data of certain systems presented on Bode plot and asymptotically approximated is shown below. **5**

Evaluate the transfer function.



5	a	Given $T(z) = N(z)/D(z)$, where $D(z) = z^3 - z^2 - 0.5z+0.3$, use the Routh-Hurwitz criterion to evaluate the number of z-plane poles of $T(z)$ inside, outside, and on the unit circle. Is the system stable?	1.5
	b	Demonstrate the block diagram representation of a computer in a digital control system? Analyse the region of stability in z plane.	1.5
	c	Given a zero order hold in cascade with $G(s)=8/(s+4)$, Solve $G(z)$. The sampling period is 0.25 second.	2

4.
b)