Roll No.												

GAIN MORE KNOWLEDGE
REACH GREATER HEIGHTS

PRESIDENCY UNIVERSITY

BENGALURU

End - Term Examinations –May/June 2026

Date: 19-05-2026 **Time:** 09:30am – 12:30pm

School: SOE	**Program**: B.Tech-ECE/VLSI	
Course Code : EEE2510	**Course Name:** Control Systems Engineering	
Semester: : IV	**Max Marks**:100	**Weightage**: 50%

CO - Levels	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**	**CO6**
Marks	**12**	**16**	**2**	**34**	**10**	**26**

Instructions:

(i) Read all questions carefully and answer accordingly.
(ii) Do not write anything on the question paper other than roll number.

Part A

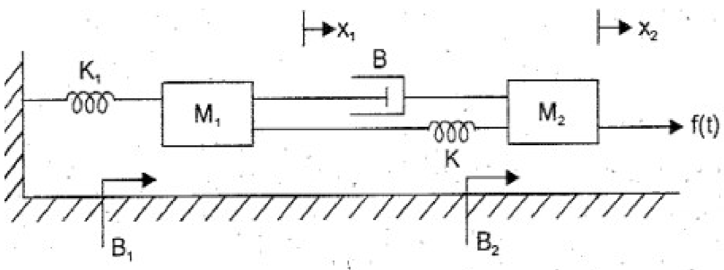
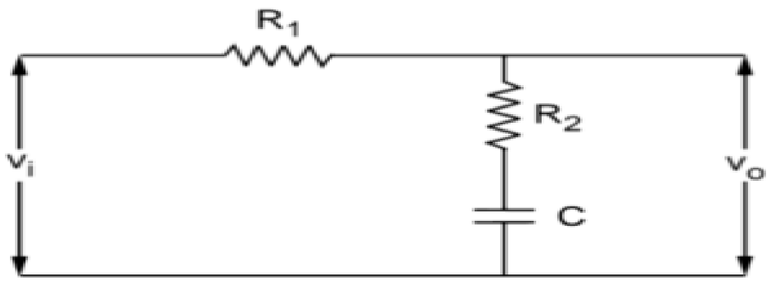
Answer ALL the Questions. Each question carries 2 marks. **10Q x 2M=20M**

1.	Define the transfer function of a linear time invariant system.	**2 Marks**	**L1**	**CO1**
2.	List the various elements present in a block diagram	**2 Marks**	**L1**	**CO2**
3.	Explain the block diagram reduction rules for the cases given below. 1. Shifting a summing point after the block 2. Shifting a summing point before the block	**2 Marks**	**L2**	**CO2**
4.	Explain the following terms for the Signal Flow Graph 1. Loop 2. Non Touching Loops	**2 Marks**	**L2**	**CO2**
5.	Recall the block diagram of the PID controller	**2 Marks**	**L1**	**CO3**
6.	Explain the effect of pole location on system stability	**2 Marks**	**L2**	**CO4**
7.	Solve for the break away point in Root locus of the open loop transfer function given below. $G(s)H(s) = \frac{K}{s(s+1)(s+2)}$	**2 Marks**	**L3**	**CO4**
8.	List the difference between linear and nonlinear systems.	**2 Marks**	**L1**	**CO6**

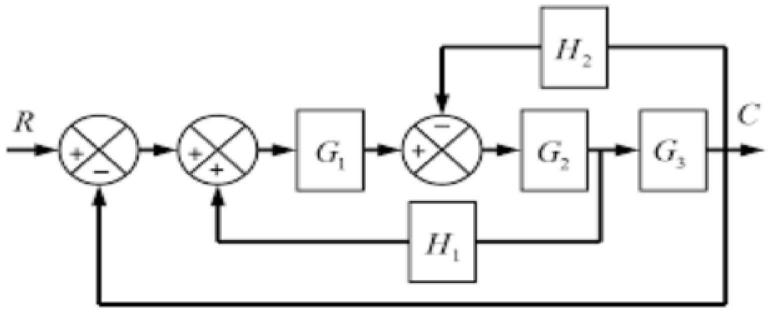
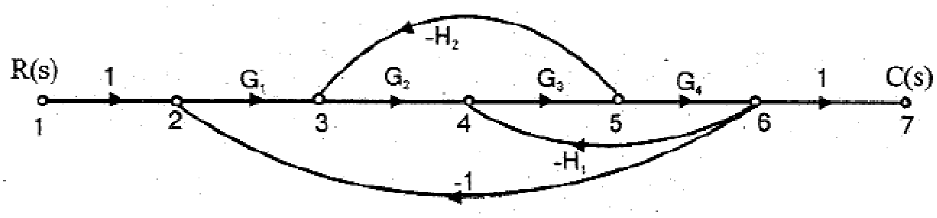
9.	Explain the state model of a linear time invariant system	**2 Marks**	**L2**	**CO6**
10.	Summarize the controllability and observability of a linear time invariant system	**2 Marks**	**L2**	**CO6**

Part B

Answer the Questions. **Total Marks 80M**

11.	**a.**	The mechanical system shown in Fig. represents a vehicle suspension–trailer coupling model, where $\boldsymbol{M_1}$is the vehicle body, $\boldsymbol{M_2}$is the trailer mass, springs model suspension stiffness, and dampers represent shock absorbers and road friction. (a) Write the differential equations governing the system. (b) Obtain the transfer function between the applied force $\boldsymbol{f(t)}$and the displacement of the trailer mass $\boldsymbol{x_2(t)}$. 	**10 Marks**	**L3**	**CO 1**
		Or			
12.	**a.**	The circuit shown in Fig. represents a first-order RC lead compensator used in control systems to improve the transient response and phase margin of a feedback system. Develop the transfer function $\frac{V_o(s)}{V_i(s)}$of the circuit. 	**10 Marks**	**L3**	**CO 1**

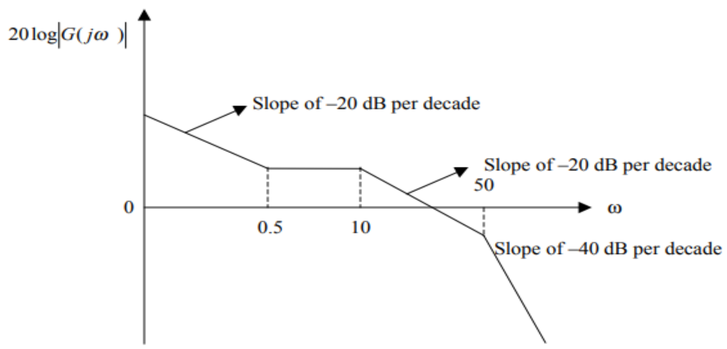
13.	**a.**	In an industrial speed control system of an electric motor, the controller, power amplifier, motor and load dynamics are represented by the blocks $\boldsymbol{G_1}, \boldsymbol{G_2}$ and $\boldsymbol{G_3}$ respectively. $\boldsymbol{H_1}$represents a tachometer feedback for inner loop stabilization and $\boldsymbol{H_2}$represents speed feedback. Applying block diagram reduction techniques, obtain the overall transfer function $\frac{\boldsymbol{C(s)}}{\boldsymbol{R(s)}}$of the system shown.	**10 Marks**	**L3**	**CO 2**

					
Or					
14.	**a.**	The signal flow graphs shown in figure represents an electronic communication systems and control systems, different subsystems such as amplifiers, sensors, and controllers. Applying Mason's Gain Formula, obtain the overall transfer function of the system 	**10 Marks**	**L3**	**CO 2**

15.	**a.**	A control systems engineer is analyzing the stability of an autopilot system in an unmanned aerial vehicle (UAV). While applying the Routh–Hurwitz Stability Criterion to the characteristic equation of the flight control system, certain irregularities arise in the Routh array that complicate stability analysis. Analyze the irregularities and explain the step-by-step procedure to resolve them.	**10 Marks**	**L4**	**CO 4**
Or					
16.	**a.**	An industrial conveyor belt system requires precise motor speed control to ensure smooth and consistent material handling. A control engineer is tasked with analyzing the stability and performance of the system using Bode plots. The open-loop transfer function of the motor drive system is provided. Explain the step by step method to construct Bode plots and analyze the stability of the system.	**10 Marks**	**L4**	**CO 4**

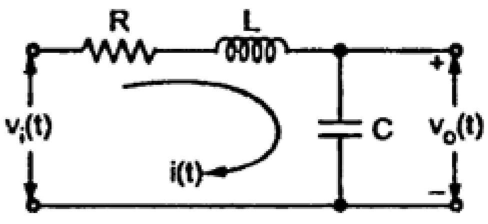
17.	**a.**	In a communication receiver system, a feedback control loop is used in the signal conditioning stage to maintain stable amplification and prevent oscillations. The characteristic equation of the closed-loop system derived from the receiver circuitry is given by: $\boldsymbol{s^6 + 4s^5 + 3s^4 - 16s^2 - 64s - 48 = 0}$ Apply the Routh–Hurwitz stability criterion to determine the stability of the communication control system. Identify the number of poles in the right half of the s-plane, if any, and comment on whether the system will produce stable or oscillatory output signals.	10 **Marks**	**L3**	**CO 4**

Or					
18.	**a.**	A unity feedback control system is used in an industrial process where stable and sustained motor operation is critical. The open-loop transfer function of the system is given by: $$G(s) = \frac{K}{s(1+0.4s)(1+0.25s)}$$ 1) Determine the range of values of gain K for which the system remains stable. 2) Identify the marginal value of K at which the system transitions to sustained oscillations. 3) Identify the frequency of sustained oscillations corresponding to marginal stability.	**10 Marks**	**L3**	**CO 4**

19.	**a.**	In a radio frequency (RF) communication receiver, an automatic gain control (AGC) loop is used to regulate the signal amplitude and maintain stable operation of the receiver. The dynamic behaviour of the AGC loop can be analysed using the root locus method. The open-loop transfer function of the unity feedback system representing the AGC loop is given by $$\frac{k}{s(s^2+8s+32)}$$ where K represents the adjustable gain of the amplifier in the feedback loop. Analyse the system stability by constructing the root locus for the given open-loop transfer function	**10 Marks**	**L4**	**CO 4**
Or					
20.	**a.**	Consider the magnitude plot of the open-loop T.F. given below a) Analyze the given plot and determine the corresponding transfer function. b) Estimate the corner frequencies from the plot. c) Comment on the type and order of the system based on the analysis 	**10 Marks**	**L4**	**CO 4**

21.	**a.**	A control engineer is designing a position control system for a robotic arm used in an automated manufacturing unit. The system exhibits steady-state error and requires improved accuracy without significantly affecting stability. To achieve this, a phase lag lead compensator is introduced in the control loop. Explain the circuit diagram, transfer function and frequency response of **a phase lag lead compensato**r with suitable diagrams.	**10 Marks**	**L2**	**CO 5**
Or					
22.	**a.**	A control engineer is working on improving the speed regulation of a DC motor drive used in an electric vehicle system. The system shows acceptable transient response but suffers from steady-state speed error under varying load conditions. To enhance low-frequency performance without significantly affecting stability, a phase lag compensator is introduced. Explain the circuit diagram, transfer function and frequency response of a **phase lag compensator** with suitable diagrams.	**10 Marks**	**L2**	**CO 5**

23.	**a.**	A control engineer is developing a high-precision motion control system for a CNC machine tool. During testing, the system exhibits inaccuracies, oscillations, and delays due to inherent nonlinear characteristics of actuators and mechanical components. Explain common types of nonlinearities that can present in control systems	**10 Marks**	**L2**	**CO 6**
Or					
24.	**a.**	A control engineer is tasked with analyzing and improving the performance of an autonomous vehicle suspension During operation, the system exhibits complex dynamic behavior that cannot be accurately described using linear models, Explain the behavior of nonlinear systems with suitable examples.	**10 Marks**	**L2**	**CO 6**

25.	**a.**	In electronics, RLC circuits are widely used in applications such as filters, oscillators, and signal conditioning circuits for processing and controlling electrical signals. Compute the state model of the RLC circuit given below. 	**10 Marks**	**L3**	**CO 6**
Or					
26.	**a.**	The state model of an electronic control system for a motor drive is given below	**10 Marks**	**L3**	**CO 6**

		$\dot{x} = \begin{bmatrix} -4 & -1.5 \\ 4 & 0 \end{bmatrix} x + \begin{bmatrix} 2 \\ 0 \end{bmatrix} u(t), \quad y = \begin{bmatrix} 1.5 & 0.625 \end{bmatrix} x$ Compute the transfer function from the given state model			