CO document

Course Name: Control System and Instrumentation (EC 601) 6th Semester; Electronics and Communication Engineering

TABLE-1

After completion of the course students will be able to-

Module	**Hr**	**Sub-Topic (from syllabus)**	**Instructional Learning Outcome(ILO) (Cognitive Process /Knowledge Dimension)**	**Topic Learning Outcome (TLO)**	**Course Outcome(CO)**
I	6	Introduction to control problem- Industrial control examples, Transfer function, open loop and closed loop (Feedback) control systems, Block diagram and Signal Flow Graph (SFG) analysis.	1.1 Compute Laplace transform. P1.1.1, P1.1.2, P1.2.1, P9.2.1, P9.2.2, P9.2.3, P9.2.4, P9.3.1, P10.1.1, P10.1.2, P10.1.3, P10.2.1, P10.2.2, P10.3.1, P10.3.2, P12.1.1 (U/CK) 1.2 Solve poles and zeroes from transfer function. P1.1.1, P1.1.2, P1.3.1, P1.4.1, P2.1.1, P2.1.2, P2.1.3, P2.4.1, P3.1.1, P3.2.1, P9.2.1, P9.2.2, P9.2.3, P9.2.4, P9.3.1, P10.1.1, P10.1.2, P10.1.3, P10.2.1, P10.2.2, P10.3.1, P10.3.2, P12.1.1 (A/CK) 1.3 Explain Open and Close loop feedback system. P1.1.1, P1.1.2, P1.2.1, P9.2.1, P9.2.2, P9.2.3, P9.2.4, P9.3.1, P10.1.1, P10.1.2, P10.1.3, P10.2.1, P10.2.2, P10.3.1, P10.3.2, P12.1.1 (U/CK) 1.4 Construct transfer function from block diagram. P1.1.1, P1.1.2, P1.3.1, P1.4.1, P2.1.2, P2.1.3, P2.4.1, P3.1.1, P3.2.1, P4.1.1, P4.1.2 , P9.2.1, P9.2.2, P9.2.3, P9.2.4, P9.3.1, P10.1.1, P10.1.2, P10.1.3, P10.2.1, P10.2.2, P10.3.1, P10.3.2, P12.1.1 (A/PK) 1.5 Construct transfer function from signal flow graph. P1.1.1, P1.1.2, P1.3.1, P1.4.1, P2.1.2, P2.1.3, P2.4.1, P3.1.1, P3.2.1, P4.1.1,	TLO1: Compute Laplace function. TLO2: Construct poles zero diagram in s plane and comment stability. TLO2: Construct transfer function from block diagram and SFG.	CO1 : Compute transfer function and pole zero diagram to find stability. **(Apply)** Assessment Tools: CT, PS, TP

			P4.1.2 , P9.2.1, P9.2.2, P9.2.3, P9.2.4, P9.3.1, P10.1.1, P10.1.2, P10.1.3, P10.2.1, P10.2.2, P10.3.1, P10.3.2, P12.1.1 (A/PK)		
II	6	Feedback control systems- Stability concept- relative stability, Routh stability criteria, steady state error (SE), steady state accuracy, disturbance rejection, insensitivity and robustness, proportional (P), integral (I) and derivative (D)controller, Realization of PID controllers with op-amp and digital implementation. Feed forward and multi loop control configurations.	2.1 Explain the Stability concept and relative stability. P1.1.1, P1.1.2, P1.2.1, P9.2.1, P9.2.2, P9.2.3, P9.2.4, P9.3.1, P10.1.1, P10.1.2, P10.1.3, P10.2.1, P10.2.2, P10.3.1, P10.3.2, P12.1.1 (U/CK) 2.2 Demonstrate Routh stability criteria. P1.1.1, P1.1.2, P1.3.1, P1.4.1, P2.1.1, P2.1.2, P2.1.3, P2.4.1, P3.1.1, P3.2.1, P9.2.1, P9.2.2, P9.2.3, P9.2.4, P9.3.1, P10.1.1, P10.1.2, P10.1.3, P10.2.1, P10.2.2, P10.3.1, P10.3.2, P12.1.1 (A/CK) 2.3 Demonstrate steady state error (SE) , steady state accuracy. P1.1.1, P1.1.2, P1.2.1, P9.2.1, P9.2.2, P9.2.3, P9.2.4, P9.3.1, P10.1.1, P10.1.2, P10.1.3, P10.2.1, P10.2.2, P10.3.1, P10.3.2, P12.1.1 (U/CK) 2.3 Explain disturbance rejection, insensitivity and robustness. P1.1.1, P1.1.2, P1.2.1, P9.2.1, P9.2.2, P9.2.3, P9.2.4, P9.3.1, P10.1.1, P10.1.2, P10.1.3, P10.2.1, P10.2.2, P10.3.1, P10.3.2, P12.1.1 (U/CK) 2.4 Demonstrate proportional (P), integral (I) and derivative (D) controller, Realization of PID controllers. P1.1.1, P1.1.2, P1.3.1, P1.4.1, P2.1.1, P2.1.2, P2.1.3, P2.4.1, P3.1.1, P3.2.1, P9.2.1, P9.2.2, P9.2.3, P9.2.4, P9.3.1, P10.1.1, P10.1.2, P10.1.3, P10.2.1, P10.2.2, P10.3.1, P10.3.2, P12.1.1 (A/CK)	TLO1: Explain the Stability and relative stability. TLO2: Demonstrate Routh stability And steady state error. TLO3: Demonstrate proportional (P), integral (I) and derivative (D) controller, Realization of PID controllers.	CO2 : Demonstrate stability applying different method , time domain analysis and different controllers. **(Apply)** Assessment Tools: CT, PS, TP

III	4	Time response of second order systems, Steady state Error (SE) and error constants, Performance specifications in time domain. Root locus method of design.	2.5 Implement Time response to calculate stability of second order systems. P1.1.1, P1.1.2, P1.3.1, P1.4.1, P2.1.2, P2.1.3, P2.4.1, P3.1.1, P3.2.1, P4.1.1, P4.1.2 , P9.2.1, P9.2.2, P9.2.3, P9.2.4, P9.3.1, P10.1.1, P10.1.2, P10.1.3, P10.2.1, P10.2.2, P10.3.1, P10.3.2, P12.1.1 (A/PK) 2.6 Demonstrate Steady state Error (SE) and different error constants. P1.1.1, P1.1.2, P1.3.1, P1.4.1, P2.1.2, P2.1.3, P2.4.1, P3.1.1, P3.2.1, P4.1.1, P4.1.2 , P9.2.1, P9.2.2, P9.2.3, P9.2.4, P9.3.1, P10.1.1, P10.1.2, P10.1.3, P10.2.1, P10.2.2, P10.3.1, P10.3.2, P12.1.1 (A/PK) 2.7 Discuss Performance specifications in time domain. P1.1.1, P1.1.2, P1.2.1, P9.2.1, P9.2.2, P9.2.3, P9.2.4, P9.3.1, P10.1.1, P10.1.2, P10.1.3, P10.2.1, P10.2.2, P10.3.1, P10.3.2, P12.1.1 (U/CK) 2.8 Construct Root locus graph and implement to find Stability of the system. P1.1.1, P1.1.2, P1.3.1, P1.4.1, P2.1.2, P2.1.3, P2.4.1, P3.1.1, P3.2.1, P4.1.1, P4.1.2 , P9.2.1, P9.2.2, P9.2.3, P9.2.4, P9.3.1, P10.1.1, P10.1.2, P10.1.3, P10.2.1, P10.2.2, P10.3.1, P10.3.2, P12.1.1 (A/PK)	TLO4: Demonstrate Time response stability and steady state error. TLO5: Implement Root locus method on system stability .	
IV	6	Frequency response analysis- Polar plots, Bode plot, stability in frequency domain, Nyquist plots. Nyquist stability criterion. Performance specifications in frequency domain. Lead and Lag compensations.	4.1 Construct Polar plots. P1.1.1, P1.1.2, P1.3.1, P1.4.1, P2.1.1, P2.1.2, P2.1.3, P2.4.1, P3.1.1, P3.2.1, P9.2.1, P9.2.2, P9.2.3, P9.2.4, P9.3.1, P10.1.1, P10.1.2, P10.1.3, P10.2.1, P10.2.2, P10.3.1, P10.3.2, P12.1.1 (A/CK)	TLO1: Sketch polar nyquist and Bode plot. TLO2: examine	CO3: Demonstrate stability in frequency domain and system compensation.

			4.2 Construct bode plots. P1.1.1, P1.1.2, P1.3.1, P1.4.1, P2.1.1, P2.1.2, P2.1.3, P2.4.1, P3.1.1, P3.2.1, P9.2.1, P9.2.2, P9.2.3, P9.2.4, P9.3.1, P10.1.1, P10.1.2, P10.1.3, P10.2.1, P10.2.2, P10.3.1, P10.3.2, P12.1.1 (A/CK) 4.3 Construct Nyquist plots. P1.1.1, P1.1.2, P1.3.1, P1.4.1, P2.1.1, P2.1.2, P2.1.3, P2.4.1, P3.1.1, P3.2.1, P9.2.1, P9.2.2, P9.2.3, P9.2.4, P9.3.1, P12.1.1 (A/CK) 4.4 Implement different plots to find system stability. P1.1.1, P1.1.2, P1.3.1, P1.4.1, P2.1.2, P2.1.3, P2.4.1, P3.1.1, P3.2.1, P4.1.1, P4.1.2 , P9.2.1, P9.2.2, P9.2.3, P9.2.4, P9.3.1, P10.1.1, P10.1.2, P10.1.3, P10.2.1, P10.2.2, P10.3.1, P10.3.2, P12.1.1 (A/PK) 4.4 Demonstrate Lead and Lag compensations. P1.1.1, P1.1.2, P1.3.1, P1.4.1, P2.1.2, P2.1.3, P2.4.1, P3.1.1, P3.2.1, P4.1.1, P4.1.2 , P9.2.1, P9.2.2, P9.2.3, P9.2.4, P9.3.1, P10.1.1, P10.1.2, P10.1.3, P10.2.1, P10.2.2, P10.3.1, P10.3.2, P12.1.1 (A/PK)	system stability. TLO3: Compute system compensation.	**(Apply)** Assessment Tools: CT, PS, TP
V	4	State Variable Analysis- Concepts of state, state variable, State Transition Matrix (STM), Solution for state variable of homogeneous and nonhomogeneous state equations, Transfer function with state space approach, Concepts of controllability and observability of systems.	5.1 Demonstrate Concepts of state, state variable. P1.1.1, P1.1.2, P1.3.1, P1.4.1, P2.1.1, P2.1.2, P2.1.3, P2.4.1, P3.1.1, P3.2.1, P9.2.1, P9.2.2, P9.2.3, P9.2.4, P9.3.1, P10.1.1, P10.1.2, P10.1.3, P10.2.1, P10.2.2, P10.3.1, P10.3.2, P12.1.1 (A/CK) 5.2 Demonstrate State Transition Matrix (STM), Solution for state variable of homogeneous and nonhomogeneous state equations. P1.1.1, P1.1.2, P1.3.1, P1.4.1, P2.1.1, P2.1.2, P2.1.3, P2.4.1, P3.1.1, P3.2.1,	TLO1: Demonstrate Concepts of state variable. TLO2: Demonstrate State Transition Matrix (STM) and Transfer	CO4 Demonstrate State variable Analysis . **(Apply)** Assessment Tools: CT, PS, TP

			P9.2.1, P9.2.2, P9.2.3, P9.2.4, P9.3.1, P10.1.1, P10.1.2, P10.1.3, P10.2.1, P10.2.2, P10.3.1, P10.3.2, P12.1.1 (A/CK) 5.3 Demonstrate Transfer function with state space approach. P1.1.1, P1.1.2, P1.3.1, P1.4.1, P2.1.1, P2.1.2, P2.1.3, P2.4.1, P3.1.1, P3.2.1, P9.2.1, P9.2.2, P9.2.3, P9.2.4, P9.3.1, P10.1.1, P10.1.2, P10.1.3, P10.2.1, P10.2.2, P10.3.1, P10.3.2, P12.1.1 (A/CK) 5.4 Demonstrate Concepts of controllability and observability of systems. P1.1.1, P1.1.2, P1.3.1, P1.4.1, P2.1.1, P2.1.2, P2.1.3, P2.4.1, P3.1.1, P3.2.1, P9.2.1, P9.2.2, P9.2.3, P9.2.4, P9.3.1, P10.1.1, P10.1.2, P10.1.3, P10.2.1, P10.2.2, P10.3.1, P10.3.2, P12.1.1 (A/CK)	function with state space. TLO3: Demonstrate Concepts of controllability and observability of systems	
VI	2	Nonlinear control systems- Basic concepts and analysis- Describing function. Introduction to optimal control problem, regulator problem, output regulator, tracking problem.	6.1 Explain optimal control problem. P1.1.1, P1.1.2, P1.2.1, P9.2.1, P9.2.2, P9.2.3, P9.2.4, P9.3.1, P10.1.1, P10.1.2, P10.1.3, P10.2.1, P10.2.2, 10.3.1, 10.3.2, P12.1.1 (U/CK) 6.2 Explain regulator problem, tracking problem. P1.1.1, P1.1.2, P1.2.1, P9.2.1, P9.2.2, P9.2.3, P9.2.4, P9.3.1, P10.1.1, P10.1.2, P10.1.3, P10.2.1, P10.2.2, P10.3.1, P10.3.2, P12.1.1 (U/CK)	TLO1: Explain optimal control problem.	CO5: Explain Optimal control system and different instrument. **(Understand)** Assessment Tools: PS, TP
VII	6	CRO- measurement with it and its function with block diagram representation. Wave and Spectrum analyzers- requirements of these instruments and their functions with block diagrams. LVDT. DC and AC servomotors, tacho generators, electro hydraulic valves, hydraulic servomotors, electro pneumatic valves, pneumatic actuators.	6.3 Explain CRO operating principle. P1.1.1, P1.1.2, P1.2.1, P9.2.1, P9.2.2, P9.2.3, P9.2.4, P9.3.1, P12.1.1 (U/CK) 6.4 Explain LVDT. DC and AC servomotors, tacho generators. P1.1.1, P1.1.2, P9.2.1, P9.2.2, P9.2.3, P9.2.4, P9.3.1, P1.2.1, P10.1.1, P10.1.2, P10.1.3, P10.2.1, P10.2.2, P10.3.1, P10.3.2, P12.1.1 (U/CK)	TLO2: Explain CRO operation. TLO3; Explain LVDT. Servomotors, generators	

			6.5 Explain electro hydraulic valves, hydraulic servomotors. P1.1.1, P1.1.2, P9.2.1, P9.2.2, P9.2.3, P9.2.4, P9.3.1, P10.1.1, P10.1.2, P10.1.3, P10.2.1, P10.2.2, P10.3.1, P10.3.2, P12.1.1 (U/FK) 6.6 Explain electro pneumatic valves, pneumatic actuators. P1.1.1, P1.1.2, P9.2.1, P9.2.2, P9.2.3, P9.2.4, P9.3.1, P10.1.1, P10.1.2, P10.1.3, P10.2.1, P10.2.2, P10.3.1, P10.3.2, P12.1.1 (U/FK)	TLO4: Explain electro hydraulic pneumatic valves	

Summary of sub topic of CO-PO of CO and POs relation

CO	No of ILOs	NO of PI associated with POs	% of ILOs related with POs
CO1	12	PO1: 5 , PO9: 7, PO10: 7, PO12: 6	PO1 – 3 60(%), PO9 -5(71.4%), PO10 -7(100%), PO12 – 1 (16.66%)
CO2	6	PO1: 5 , PO2: 13 , PO3: 13, PO9: 7 , PO10: 7, PO12: 6	PO1 – 5 (100%), PO2 – 3 (15.3%), PO3-2(15.38%), PO9 -5(71.4%), PO10 -7(100%), PO12 – 1 (16.66%)
CO3	3	PO1: 5 , PO2: 13 , PO3: 13 , PO9: 7 , PO4:10 , PO10: 7, PO12: 6	PO1 – 4 (80%), PO2 – 1 (7.69%), PO3- 2(15.38%), PO4 – 2 (%), PO9 -5(71.4%), PO10 -7(100%), PO12 – 1 (16.66%)
CO4	9	PO1: 05 , PO2: 13 , PO3: 13 , PO4:10, PO9: 7 , PO10: 7, PO12: 6	PO1 – 4 (80%), PO2 – 3 (15.3%), PO3-2(15.38%), PO4 – 2 (20%), PO9 -5(71.4%), PO10 -7(100%), PO12 – 1 (16.66%)
CO5	6	PO1: 05 , PO2: 13 , PO3: 13 , PO4:10, PO9: 7 , PO10: 7, PO12: 6	PO1 – 4 (80%), PO2 – 3 (15.3%), PO3-2(15.38%), PO4 – 2 (20%) , PO9 -5(71.4%), PO10 -7(100%), PO12 – 1 (16.66%)

CO-PO mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1							1	1		1	3	2
CO2	3	2	1						1	1		1	3	2
CO3	3	2	1	1					1	1		1	3	2
CO4	3	2	1	1					1	1		1	3	2
CO5	3	2	1	1					1	1		1	3	2
Course	**3**	**1.8**	**0.8**	**0.6**					**1.00**	**1.00**		**1.00**	**3.00**	**2.00**

Rubric for CO PO PSO mapping:

Methods	**Attainment Levels**	
=PI mapped with CO/PO given	Level 1	>20
	Level 2	<=20 and <50
	Level 3	<=50