

Department of Electrical and Electronics Engineering

COURSE MODULES OF THE SUBJECT TAUGHT FOR THE SESSION ODD SEM 2023-2024

Course Syllabi with CO's

Control Systems			
IPCC Course Code	21EE52	CIE Marks	50
Teaching Hours/Week (L:T:P)	3:0:2:0	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory + 11 Lab	Total Marks	100
Credits	04	Exam Hours	03
Course objectives: (1) To analyze and model electrical and mechanical system using analogous systems. (2) To formulate transfer functions using block diagram and signal flow graphs. (3) To analyze the stability of control system, ability to determine transient and steady state time response. (4) To illustrate the performance of a given system in time and frequency domains, stability analysis using Root locus and Bode plots. (5) To discuss stability analysis using Nyquist plots, Design controller and compensator for a given specification. (6) To utilize software package and discrete components in assessing the time and frequency domain response of a given second order system. (7) To design, analyze and simulate Lead, Lag and Lag – Lead compensators for given specifications. (8) To determine the performance characteristics of AC and DC servomotors and synchro-transmitter receiver pair used in control systems. (9) To simulate the DC position and feedback control system to study the effect of P, PI, PD and PID controller and Lead compensator on the step response of the system. (10) To develop a script file to plot Root locus, Bode plot and Nyquist plot to study the stability of a system using software package			
Teaching-Learning Process (General Instructions) These are sample Strategies; which teachers can use to accelerate the attainment of the various course outcomes. 1. Lecturer method (L) needs not to be only traditional lecture method, but alternative effective teaching methods could be adopted to attain the outcomes. 2. Use of Video/Animation to explain functioning of various concepts. 3. Encourage collaborative (Group Learning) Learning in the class. 4. Ask at least three HOT (Higher order Thinking) questions in the class, which promotes critical thinking. 5. Adopt Problem Based Learning (PBL), which fosters students’ Analytical skills, develop design thinking skills such as the ability to design, evaluate, generalize, and analyses information rather than simply recall it. 6. Introduce Topics in manifold representations. 7. Show the different ways to solve the same problem with different circuits/logic and encourage the students to come up with their own creative ways to solve them. 8. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the			
MODULE-1			
Introduction to Control Systems: Introduction, classification of control systems. Mathematical models of physical systems: Modelling of mechanical system elements, electrical systems, Analogous systems, Transfer function, Single input single output systems, Procedure for deriving transfer functions, servomotors, synchros, gear trains.			
Teaching-Learning Process	Chalk and Board, Power Point Presentation.		
MODULE-2			
Block Diagram: Block diagram of a closed loop system, procedure for drawing block diagram and block diagram reduction to find transfer function. Signal Flow Graphs: Construction of signal flow graphs, basic properties of signal flow graph, signal flow graph algebra, construction of signal flow graph for control systems.			
Teaching-Learning Process	Chalk and Board, Power Point Presentation.		
MODULE-3			

Department of Electrical and Electronics Engineering

Time Domain Analysis: Standard test signals, time response of first order systems, time response of second order systems, steady state errors and error constants. Routh Stability Criterion: BIBO stability, Necessary conditions for stability, Routh stability criterion, difficulties in formulation of Routh table, application of Routh stability criterion to linear feedback systems, relative stability analysis.		
Teaching-Learning Process		Chalk and Board, Power Point Presentation.
MODULE-4		
Root locus Technique: Introduction, root locus concepts, construction of root loci, rules for the construction of root locus. Frequency Response Analysis: Co-relation between time and frequency response – 2nd order systems only. Bode Plots: Basic factors $G(j\omega)/H(j\omega)$, General procedure for constructing bode plots, computation of gain margin and phase margin.		
Teaching-Learning Process		Chalk and Board, Power Point Presentation.
MODULE-5		
Nyquist plot: Principle of argument, Nyquist stability criterion, assessment of relative stability using Nyquist criterion. Design of Control Systems: Introduction, Design with the PD Controller, Design with the PI Controller, Design with the PID Controller, Design with Phase-Lead Controller, Design with Phase - Lag Controller, Design with Lead-Lag Controller.		
Teaching-Learning Process		Chalk and Board, Power Point Presentation.
Sl. NO	Experiments	
1	Experiment to draw the speed torque characteristics of (i) AC servo motor (ii) DC servo motor.	
2	Experiment to draw synchro pair characteristics.	
3	Experiment to determine frequency response of a second order system.	
4	(a) To design a passive RC lead compensating network for the given specifications, viz, the maximum phase lead and the frequency at which it occurs and to obtain the frequency response.	
5	(a) To design a passive RC lag compensating network for the given specifications, viz, the maximum phase lag and the frequency at which it occurs and to obtain the frequency response. (b) To determine experimentally the transfer function of the lag compensating network.	
6	Experiment to draw the frequency response characteristics of the lag – lead compensator network and determination of its transfer function.	
7	To study a second order system and verify the effect of (a) P, (b) PI, (c) PD and (d) PID controller on the step response.	
8	(a) To simulate a typical second order system and determine step response and evaluate time response specifications. (b) To evaluate the effect of adding poles and zeros on time response of second order system. (c) To evaluate the effect of pole location on stability.	
9	(a) To simulate a D.C. Position control system and obtain its step response. (b) To verify the effect of input waveform, loop gain and system type on steady state errors. (c) To perform trade-off study for lead compensator. (d) To design PI controller and study its effect on steady state error.	
10	(a) To examine the relationship between open-loop frequency response and stability, open-loop frequency and closed loop transient response. (b) To study the effect of open loop gain on transient response of closed loop system using root locus.	
11	(a) To study the effect of open loop poles and zeros on root locus contour. (b) Comparative study of Bode, Nyquist and root locus with respect to stability.	

Department of Electrical and Electronics Engineering

Note:

1. Perform experiments 1 and 2 using suitable components/equipment.
2. Perform experiments 3,4,5,6 and 7 using suitable components/equipment and verify the results using standard simulation package.
3. Perform simulation only of experiments 8,9,10 and 11 using standard package.

Course outcomes (Course Skill Set):

At the end of the course the student will be able to:

- CO.1. Analyze the modelling of mechanical and electrical systems and develop the transfer functions of the control systems. [L4]
- CO.2. Analyze and develop the transfer function of the system by using block diagram reduction technique and signal flow graph. [L4]
- CO.3. Analyze the time response of first order and second order system and determine the stability of system using RH criteria. [L4]
- CO.4. Analyze the stability of the system using Root Locus and Bode plot. [L4]
- CO.5. Analyze the stability of the system using nyquist plot and design the controllers and compensators. [L4]

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50) in the semester-end examination (SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

CIE for the theory component of IPCC

Two Tests each of **20 Marks (duration 01 hour)**

- First test at the end of 5th week of the semester
- Second test at the end of the 10th week of the semester

Two assignments each of **10 Marks**

- First assignment at the end of 4th week of the semester
- Second assignment at the end of 9th week of the semester

Scaled-down marks of two tests and two assignments added will be CIE marks for the theory component of IPCC for **30 marks**.

CIE for the practical component of IPCC

- On completion of every experiment/program in the laboratory, the students shall be evaluated and marks shall be awarded on the same day. The **15 marks** are for conducting the experiment and preparation of the laboratory record, the other **05 marks shall be for the test** conducted at the end of the semester.
- The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report. Each experiment report can be evaluated for 10 marks. Marks of all experiments' write-ups are added and scaled down to 15 marks.
- The laboratory test (**duration 03 hours**) at the end of the 15th week of the semester /after completion of all the experiments (whichever is early) shall be conducted for 50 marks and scaled down to 05 marks.

Scaled-down marks of write-up evaluations and tests added will be CIE marks for the laboratory component of IPCC for **20 marks**.

Department of Electrical and Electronics Engineering

SEE for IPCC

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (duration 03 hours)

- The question paper will have ten questions. Each question is set for 20 marks.
- There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
- The students have to answer 5 full questions, selecting one full question from each module.

The theory portion of the IPCC shall be for both CIE and SEE, whereas the practical portion will have a CIE component only. Questions mentioned in the SEE paper shall include questions from the practical component).

- The minimum marks to be secured in CIE to appear for SEE shall be the 12 (40% of maximum marks-30) in the theory component and 08 (40% of maximum marks -20) in the practical component. The laboratory component of the IPCC shall be for CIE only. However, in SEE, the questions from the laboratory component shall be included. The maximum of 04/05 questions to be set from the practical component of IPCC, the total marks of all questions should not be more than the 20 marks.
- SEE will be conducted for 100 marks and students shall secure 35% of the maximum marks to qualify in the SEE. Marks secured will be scaled down to 50.

Suggested Learning Resources:

1. Control Systems, Anand Kumar, PHI, 2nd Edition, 2014
2. Automatic Control Systems, Farid Golnaraghi, Benjamin C. Kuo, Wiley, 9th, Edition, 2010.
3. Control System Engineering, Norman S. Nise, Wiley, 4th Edition, 2004
4. Modern Control Systems, Richard C Dorf et al, Pearson, 11th Edition, 2008
5. Control Systems, Principles and Design, M. Gopal, McGrawHill 4th Edition, 2012
6. Control Systems Engineering, S. Salivahanan et al, Pearson 1st Edition, 2015.

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

Activity Based Learning, Quizzes, Seminars.

The Correlation of Course Outcomes (CO's) and Program Outcomes (PO's)

Course Code:	21EE52	TITLE: Control Systems							Faculty Member: Kavyashree S			
List of Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO-1	3	3	-	-	3	-	-	-	-	-	-	3
CO-2	3	3	-	-	-	-	-	-	-	-	-	3
CO-3	3	3	-	-	3	-	-	-	-	-	-	3
CO-4	3	3	-	-	3	-	-	-	-	-	-	3
CO-5	3	3	3	-	3	-	-	-	-	-	-	3

Note: 3 = Strong Contribution 2 = Average Contribution 1= Weak Contribution - = No Contribution

Department of Electrical and Electronics Engineering

The Correlation of Course Outcomes (CO's) and Program Specific Outcomes (PSO's)

Course Code:	21EE52	TITLE: Control Systems
List of Course Outcomes	Program Specific Outcomes	
	PSO1	PSO2
CO-1	3	-
CO-2	3	-
CO-3	3	-
CO-4	3	-
CO-5	3	-

Note: 3 = Strong Contribution 2 = Average Contribution 1 = Weak Contribution - = No Contribution