EEL411	CONTROL SYSTEMS LAB	CATEGORY	L	T	P	CREDIT
		PCC	0	0	3	2

Preamble: This Laboratory Course provides a platform for modelling and analysis of linear and nonlinear systems with the help of hardware and software tools in the control framework.

Prerequisite: EET302 Linear Control Systems, EET305 Signals and Systems

Course Outcomes: After the completion of the course the student will be able to

CO 1	Demonstrate the knowledge of simulation tools for control system design.
CO 2	Develop the mathematical model of a given physical system by conducting appropriate experiments.
CO 3	Analyse the performance and stability of physical systems using classical and advanced control approaches.
CO 4	Design controllers for physical systems to meet the desired specifications.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	3	2	3	3			3	3	3		3
CO 2	3	3	3	3	3			3	3	3		3
CO 3	3	3	3	3	3			3	3	3		3
CO 4	3	3	3	3	3			3	3	3		3

Assessment Pattern

Mark distribution

Total Marks	CIE	ESE	ESE Duration

150	75	75	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 15 marks

Continuous Assessment : 30 marks

Internal Test : 30 marks

End Semester Examination Pattern: The following guidelines should be followed regarding award of marks

(a) Preliminary work : 15 Marks

(b) Implementing the work/Conducting the experiment : 10 Marks

(c) Performance, result and inference (usage of equipments and troubleshooting) : 25 Marks

(d) Viva voce : 20 marks

(e) Record : 5 Marks

General instructions:

Practical examination to be conducted immediately after the second series test after completing 12 experiments out of the 18 experiments given below. Evaluation is a serious process that is to be conducted under the equal responsibility of both the internal and external examiners. The number of candidates evaluated per day should not exceed 20. Students shall be allowed for the University examination only on submitting the duly certified record. The external examiner shall endorse the record.

Reference Books

1. Richard C. Dorf and Robert H. Bishop, Modern Control Systems, Eleventh Edition, Pearson Education 2009.

2. Katsuhiko Ogatta, Modern Control Engineering, Fourth Edition, Pearson Education,2002.

List of Exercises/Experiments: (Lab experiments may be given considering 12 sessions of 3 hours each.)

1. Simulation tools like MATLAB/ SCILAB or equivalent may be used.
2. All experiments done by the students in addition to 12 experiments may be treated as beyond syllabus experiments.

Experiment No.	Name of the experiment
1	**Step response of a second order system.** Objective: Design a second order system (eg: RLC network) to analyse the following: A. The effect of damping factor (ξ: 0, <1,=1,>1) on the unit step response using simulation study (M-File and SIMULINK). B. Verification of the delay time, rise time, peak overshoot and settling time with the theoretical values. C. Performance analysis of hardware setup and comparison with the simulation results.
2	**Performance Analysis using Root-Locus Method.** Objective: Plot the root locus of the given transfer function to analyse the following using simulation: A. Verification of the critical gain, wo with the theoretical values B. The effect of controller gain K on the stability C. The sensitivity analysis by giving small perturbations in given poles and zeros D. The effect of the addition of poles and zeros on the given system.

3	**Stability Analysis by Frequency Response Methods.** Objective: Plot the i) Bode plot and ii) Nyquist plot of the given transfer functions to analyse the following using simulation: A. Determination of Gain Margin and Phase Margin B. Verification of GM and PM with the theoretical values C. The effect of controller gain K on the stability, D. The effect of the addition of poles and zeros on the given system (especially the poles at origin).
4	**Realisation of lead compensator.** Objective: Design, set up and analyse the gain and phase plots of a lead compensator by hardware experimentation using i) passive elements and ii) active components..
5	**Realisation of lag compensator.** Objective: Design, set up and analyse the gain and phase plots of a lag compensator by hardware experimentation using i) passive elements and ii) active components..
6	**Design of compensator in frequency domain and time domain.** Objective: Design a compensator for the given system to satisfy the given specifications A. Time domain specifications using MATLAB B. Frequency domain specifications using MATLAB
7	**State space model for analysis and design** Objective: Study and analysis of state variable model of a given system (eg. DC Motor speed control/ Servo motor/etc) and design a controller by pole-placement technique using MATLAB based tool boxes. A. Determine the open loop stability, controllability and observability B. Analyse the effect of system parameters on eigen values and system performance.

	C. Design a controller by pole-placement technique.
8	**PID Controller Design** Objective: Design and analysis of a PID controller for a given system (eg. DC Motor speed control/ Servo motor/etc) using SIMULINK/ MATLAB based tool boxes A. Design of PID controller to meet the given specifications B. Study the effect of tuning of PID controller on the above system.
9	**Phase plane analysis of nonlinear autonomous systems** Objective: Study and analysis of phase trajectory of a given nonlinear autonomous system using state space model in Simulation tools. A. Determination and verification of the singular points, B. Stability Analysis of the system at various singular points from phase portraits.
10	**Transfer Function of Armature and Field Controlled DC Motor** Objective: Obtain the transfer function of the armature and field controlled DC motor by experiment.
11	**Synchro Transmitter and Receiver.** Objective: Plot and study the different performance characteristics of Synchro transmitter- receiver units in Direct mode and Differential mode.
12	**Transfer function of Separately excited DC Generator.** Objective: Obtain the open loop transfer function of a separately excited DC Generator by experiment.

13	**Transfer function of A.C. Servo motor.** Objective: Obtain the open loop transfer function of AC Servo motor by experiment.
14	**Performance of a typical process control system** Objective: Study of performance characteristics and response analysis of a typical temperature/ Flow/ Level control system.
15	**Closed loop performance of inverted pendulum.** Objective: Study of performance characteristics of inverted pendulum by experiment. A. Determine the various unknown parameters of an inverted pendulum experimentally, B. Obtain and analyse the non-linear and linearised models, C. Design and implement various state feedback controllers to analyse the performance of the system.
16	**Performance analysis of magnetic levitation system.** Objective: Study of performance of magnetic levitation system by experiment. A. Obtain and analyse the dynamics of a magnetic levitation system, B. Design and implement various loop controllers to analyse the performance of this experimental system while tracking in presence/absence of disturbances.
17	**Closed loop performance of Twin rotor system** Objective: Study of performance characteristics of Twin rotor system by experiment.

18	**Mass Spring Damper system** Objective: Study of performance characteristics of Mass-Damper-Spring system by experiment. A. Determine the various unknown parameters of a mass spring damper system experimentally to obtain transfer function/ state space models, B. Design and implement various state feedback controllers to analyse the performance of the system while regulation and tracking