INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad -500 043

ELECTRICAL AND ELECTRONICS ENGINEERING

COURSE DESCRIPTOR

Course Title	**CONTROL SYSTEM AND SIMULATION LABORATORY**				
Course Code	AEE115				
Programme	B.Tech				
Semester	IV	EEE			
Course Type	Core				
Regulation	IARE - R16				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	-	-	-	3	2
Chief Coordinator	Ms. B Navothna, Assistant Professor				
Course Faculty	Dr. P Sridhar, Professor & HOD,EEE Dr. T Devaraju, Professor,EEE				

I. COURSE OVERVIEW:

This course is aimed to introduce the students the principles and applications of control systems in everyday life. The basic concepts of block diagram reduction, time response analysis solutions to time invariant systems and it also deals with the different aspects of stability analysis of systems in frequency domain and time domain. Introduction and Implementation of PLC'S for practical applications in control systems.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
UG	AHS011	II	Mathematical Transform techniques	4
UG	AHS102	I	Computational Mathematics Laboratory	1

III. MARKS DISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Control System And Simulation Laboratory	70 Marks	30 Marks	100

IV. DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✔	Chalk & Talk	✘	Quiz	✘	Assignments	✘	MOOCs
✔	LCD / PPT	✘	Seminars	✘	Mini Project	✘	Videos
✔	Open Ended Experiments						

V. EVALUATION METHODOLOGY:

Each laboratory will be evaluated for a total of 100 marks consisting of 30 marks for internal assessment and 70 marks for semester end lab examination. Out of 30 marks of internal assessment, continuous lab assessment will be done for 20 marks for the day to day performance and 10 marks for the final internal lab assessment.

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the lab courses is divided into fourteen weeks. From 1^{st} to 7^{th} week hardware and MATLAB based experiments and from 8^{th} to 14^{th}week PLC based experiments will be carried out. Among the 14 experiments, one compulsory question without any choice will be given for SEE.

The emphasis on the experiments is broadly based on the following criteria:

20 %	To test the preparedness for the experiment.
20 %	To test the performance in the laboratory.
20 %	To test the calculations and graphs related to the concern experiment.
20 %	To test the results and the error analysis of the experiment.
20 %	To test the subject knowledge through viva – voce.

Continuous Internal Assessment (CIA):
The CIE exam is conducted for 30 marks for internal evaluation (20 marks for day-to-day work, and 10 marks for internal tests). There shall be one internal test for 10 marks in the Semester.

Table 1: Assessment pattern for CIA

Component	**Laboratory**		**Total Marks**
Type of Assessment	Day to day performance	Final internal lab assessment	
CIA Marks	20	10	30

Continuous Internal Examination (CIE):
Two CIE exams shall be conducted at the end of the 8^{th} and 16^{th} week of the semester respectively. The CIE exam is conducted for 10 marks of 3 hours duration. Marks are awarded by taking average of marks scored in two CIE exams.

Preparation	**Performance**	**Calculations and Graph**	**Results and Error Analysis**	**Viva**	**Total**
2	2	2	2	2	10

VI. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes (POs)		Strength	Proficiency assessed by
PO 1	**Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	2	Calculations of the observations
PO 2	**Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	2	Calculations of the observations
PO 3	**Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.	3	Characteristic curves
PO 4	**Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	2	Laboratory Practices
PO 5	**Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations	2	Projects

3 = High; 2 = Medium; 1 = Low

VII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes (PSOs)		Strength	Proficiency assessed by
PSO 1	Able to utilize the knowledge of high voltage engineering in collaboration with power systems in innovative, dynamic and challenging environment, for the research based team work.	2	Projects
PSO 2	Can explore the scientific theories, ideas, methodologies and the new cutting edge technologies in renewable energy engineering, and use this erudition in their professional development and gain sufficient competence to solve the current and future energy problems universally.	-	-
PSO 3	The understanding of technologies like PLC, PMC, process controllers, transducers and HMI one can analyze, design electrical and electronics principles to install, test , maintain power system and applications.	3	Laboratory Practices

3 = High; 2 = Medium; 1 = Low

VIII. COURSE OBJECTIVES (COs):

The course should enable the students to:	
I	Understand mathematical models of electrical and mechanical systems.
II	Analysis of control system stability using digital simulation.
III	Demonstrate the time domain and frequency domain analysis for linear time invariant systems.
IV	Apply programmable logic controllers to demonstrate industrial controls in the laboratory.

IX. COURSE LEARNING OUTCOMES (CLOs):

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
AEE115.01	CLO 1	Demonstrate the response of first order and second order systems with various standard test signals.	PO1, PO2, PSO1	2
AEE115.02	CLO 2	Understand the concept of time domain analysis of series RLC Circuit.	PO1, PO2, PSO1	2
AEE115.03	CLO 3	Identify the transfer function and analyze the time response of DC motor.	PO1, PO2, PSO1	2
AEE115.04	CLO 4	Examine the speed torque characteristics of AC Servomotor.	PO2, PO3, PSO1	3
AEE115.05	CLO 5	Estimate the error obtained in control system with the effect of P, PI, PID controllers.	PO3, PO4, PSO1	2
AEE115.06	CLO 6	Design of lead, lag, lag-lead compensator to improve characteristics of control system.	PO3, PO4, PSO1	2
AEE115.07	CLO 7	Record the dynamic behavior of temperature control system with P, PI, PID controllers.	PO2, PO3, PSO1	2
AEE115.08	CLO 8	Construct the PID controller using Op-Amps and verify using MATLAB.	PO2, PO3, PSO3	2
AEE115.09	CLO 9	Analyze the stability of time invariant control system using root locus, bode plot, polar plot, nyquist criterions.	PO2, PO5, PSO1	2
AEE115.10	CLO 10	Calculate the transfer function from state space model and state space model from transfer function using MATLAB	PO2, PO5, PSO3	3
AEE115.11	CLO 11	Implement ladder diagrams, truth tables, counter, blinking of lights ,control of water level using PLC	PO2, PO3, PO5, PSO3	3
AEE115.12	CLO 12	Implement ladder diagrams for blinking of lights ,control of water level using PLC	PO2, PO3, PO5, PSO3	2

3 = High; 2 = Medium; 1 = Low

X. MAPPING COURSE LEARNING OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Learning Outcomes (CLOs)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CLO 1	2	2											2		
CLO 2	2	2											2		
CLO 3	2	2											2		
CLO 4		2	3										2		
CLO 5			3	2									2		
CLO 6			2	2									2		
CLO 7		2	2										2		
CLO 8		2	3												3
CLO 9		2			2										3

Course Learning Outcomes (CLOs)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CLO 10		2			2										3
CLO 11		2	3		2										3
CLO 12		2	3		2										3

3 = High; 2 = Medium; 1 = Low

XI. ASSESSMENT METHODOLOGIES – DIRECT

CIE Exams	PO 1, PO 2 PO 3, PO 4, PO 5	SEE Exams	PO 1, PO 2 PO 3, PO 4, PO 5	Assignments	-	Seminars	-
Laboratory Practices	PO 1, PO 2 PO 3, PO 4,PO 5	Student Viva	PO 1, PO 2 PO 3,PO 4, PO 5	Mini Project	-	Certification	-

XII. ASSESSMENT METHODOLOGIES - INDIRECT

✔	Early Semester Feedback	✔	End Semester OBE Feedback
✘	Assessment of Mini Projects by Experts		

XIII. SYLLABUS

LIST OF EXERCISES	
Week-1	**TIME RESPONSE OF SECOND ORDER SYSTEM**
To obtain the time response of a given second order system with time domain specifications.	
Week-2	**TRANSFER FUNCTION OF DC MOTOR**
Determine the transfer function, time response of DC motor and verification with digital simulation.	
Week-3	**AC SERVO MOTOR**
Study of AC servomotor and plot its torque speed characteristics.	
Week-4	**EFFECT OF VARIOUS CONTROLLERS ON SECOND ORDER SYSTEM**
Study the effect of P, PD, PI and PID controller on closed loop second order systems.	
Week-5	**COMPENSATOR**
Study lead-lag compensator and obtain its magnitude, phase plots.	
Week-6	**TEMPERATURE CONTROLLER**
Study the performance of PID controller used to control the temperature of an oven.	
Week-7	**DESIGN AND VERIFICATION OF OP-AMP BASED PID CONTROLLER**
Implementation of op-amp based PID Controller and verification using MATLAB	

Week-8	STABILITY ANALYSIS USING DIGITAL SIMULATION
Stability analysis using root locus, Bode plot, Polar, Nyquist criterions of linear time invariant system by digital simulation.	
Week-9	**STATE SPACE MODEL USING DIGITAL SIMULATION**
Verification of state space model from transfer function and transfer function from state space model using digital simulation.	
Week-10	**LADDER DIAGRAMS USING PLC**
Input output connection, simple programming, ladder diagrams, uploading, running the program and debugging in programmable logic controller.	
Week-11	**TRUTH TABLES USING PLC**
Study and verification of truth tables of logic gates, simple boolean expressions and application to speed control of DC motor using programmable logic controller.	
Week-12	**IMPLEMENTATION OF COUNTER**
Implementation of counting number of objects and taking action using PLC.	
Week-13	**BLINKING LIGHTS USING PLC**
Implementation of blinking lights with programmable logic controller.	
Week-14	**WATER LEVEL CONTROL**
Control of maximum and minimum level of water in a tank using PLC.	

TEXT BOOKS:

1	Norman S. Nise, "Control Systems Engineering", John Wiley & Sons, Inc., 6th Edition, 2004.
2	J Nagrath, M Gopal, "Control Systems Engineering", New Age International, 3rd Edition, 2007.
3	John W. webb, Ronald A.Reis, "Programmable Logic Controllers, Principles and Applications",5th Edition, 2002.
4	A Nagoor Kani, "Control Systems", RBA Publications,1st Edition, 2009.

REFERENCES:

1	Benjamin Kuo, "Automatic Control Systems", PHI, 7th Edition, 1987.
2	K Ogata, "Modern Control Engineering", Prentice Hall, 4th Edition, 2003.

XIV. COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

Week No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
1	Time response of second order system	CLO 1	T1:4.4
2	Transfer Function Of Dc Motor	CLO 2	T4:1.7
3	Perform the experiment on AC Servo Motor and to study its performance characteristics	CLO 3	T4:2.6
4	Effect Of Various Controllers on Second Order System	CLO 4	T4:3.8
5	Compensator Design-lead, lag and lead-lag	CLO 5	T1:4.8

Week No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
6	Temperature Controller	CLO 6	T1:3.8
7	Design and Verification Of Op-Amp Based PID Controller	CLO 7	T1:3.8
8	Stability Analysis Using Digital Simulation-Root Locus, Bode Plot, nyquist and polar plots.	CLO 8	T1:6.5
9	State Space Model Using Digital Simulation	CLO 9	T1:6.5
10	Introduction to programmable logic controllers and applications	CLO 11	T4
11	Develop basic ladder diagrams truth tables, counter, blinking of lights ,control of water level using PLC	CLO 12	T4
12	Develop ladder diagrams for truth tables-AND,NAND,OR,NOR.	CLO 12	T4
13	Develop basic ladder diagrams for implementation of counter	CLO 12	T4
14	Develop basic ladder diagrams for blinking of lights ,control of water level using PLC	CLO 12	T4

XV. GAPS IN THE SYLLABUS - TO MEET INDUSTRY / PROFESSION REQUIREMENTS:

S No	Description	Proposed actions	Relevance with POs	Relevance with PSOs
1	Describe the importance of PID controller for controlling the temperature of an oven	Laboratory Practices	PO 2, PO 3	PSO 1
2	Design of lead-lag compensator to improve stability of control system.	Projects	PO 3, PO4	PSO 1
3	Verify the stability of time invariant control system using root locus, bode plot, polar plot, nyquist criterions using MATLAB.	Calculations of the observations	PO 2,PO 5	PSO 3
4	Develop ladder diagrams, truth tables, counter, blinking of lights ,control of water level using PLC	Laboratory Practices	PO 2,PO 5	PSO 3

Prepared by:
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HOD, EEE