INSTITUTE OF AERONAUTICAL ENGINEERING

Dundigal, Hyderabad - 500 043

ELECTRONICS AND COMMUNICATION ENGINEERING

COURSE DESCRIPTION FORM

Course Title	**CONTROL SYSTEMS ENGINEERING**			
Course Code	**R13-A50217**			
Regulation	**R13 – JNTUH**			
Course Structure	Lectures	Tutorials	Practical's	Credits
	4	1	-	4
Course Coordinator	Dr. K Nehru, professor, ECE			
Team of Instructors	Mr. N. Nagaraju, Assistant Professor, ECE			

I. COURSE OVERVIEW

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

II. PREREQUISITE(S)

Level	Credits	Periods/ Week	Prerequisites
UG	4	4	Knowledge of systems, linear and non-linear control systems

III. MARKS DISTRIBUTION

Sessional Marks (25 Marks)	University End Marks	Total Marks
Mid Semester Test There shall be 2 midterm examinations. Each midterm examination consists of subjective type and Objective type tests. The subjective test is for 10 marks, with duration of 1 hour. Subjective test of each semester shall contain 4 questions The student has to answer 2 questions, each carrying 5 marks. The objective type test is for 10 marks with duration of 20minutes. It consists of 10 Multiple choice and 10 objective type questions. The student has to answer all the questions and each carries half mark. First midterm examination shall be conducted for the first 21/2 unit of syllabus and second midterm examination shall be conducted for the remaining portion. Five marks are earmarked for assignments. There shall be two assignments in every theory course. Marks shall be awarded considering the average of two assignments in each course reason whatsoever, will get zero marks(s).the conduct of the second mid-examination. The total marks secured by the student in each mid-term examination are evaluated for 25 marks, and the average of the two mid-term examinations shall be taken as the final marks secured by each candidate.	75	100

IV. EVALUATION SCHEME

S. No	Component	Duration	Marks
1.	I Mid Examination	80 minutes	20
2.	I Assignment	-	5
3.	II Mid Examination	80 minutes	20
4.	II Assignment	-	5
5.	External Examination	3 hours	75

V. COURSE OBJECTIVES

At the end of the course, the students will be able to

1. Understand the principles and applications of control systems in day life and Be familiar with the linear time–invariant system and to design simple control systems.
2. Analyze time domain approach is unified method for analyzing and designing systems modeled by either by modern or classical approach.
3. Be familiar with the degree or extent of the system stability. The steady state performance and transient response.
4. Be familiar with the Computation of bode plot for given open loop transfer function, defining the stability and gain margin and phase margin for given bode, polar, nyquist plots, PID controller.
5. Be familiar with MIMO system in state variable approach.

VI. COURSE OUTCOMES

After completing this course the student must demonstrate the knowledge and ability to

1. Understand and analyze the operation of open loop and closed loop systems.
2. Analyze transfer functions for electro-dynamic plants and machines, with electrical, electro-mechanical, electro-pneumatic, and electro-hydraulic elements from plant site collected data.
3. Understand feed –back characteristics, Effects of feedback in control systems.
4. Understand and Analyze the problems related to signal flow graph Reduction using Mason's gain formula.
5. Understand and analyze Transient response of second order systems - Time domain specifications
6. Understand the Steady state response - Steady state errors and error constants the stability of a system in S – Domain using Routh's stability criterion.
7. Understand and analyze the root locus concept, Root locus and problems.
8. Understand and analyze transfer function from the Bode Diagram-Phase margin and Gain margin and different problems
9. Understand and analyze stability using polar plot.
10. Understand and analyze stability using nyquist plot.
11. Understand the concepts compensation techniques lag, lead, lead –lag controllers in frequency domain.
12. Understand the concept of state, state variables, state model.
13. Understand the concept of state model from block diagram.
14. Understand the concept of state transition matrix and their properties.

VII. HOW PROGRAM OUTCOMES ARE ASSESSED

Program Outcomes		Level	Proficiency assessed by
PO1	**Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	H	Assignments

Program Outcomes		Level	Proficiency assessed by
PO2	**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.	H	Assignments
PO3	**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.	S	Excercise
PO4	**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.	H	Assignments, discussion
PO5	**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.	S	Excercise
PO6	**The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.	N	------
PO7	**Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.	S	Excercise
PO8	**Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	H	Discussion, seminars
PO9	**Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	N	-----
PO10	**Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.	S	Discussions
PO11	**Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.	S	Discussion, seminars
PO12	**Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.	S	Discussions, seminars

N - None **S - Supportive** **H - Highly Related**

VIII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED

Program Specific Outcomes		Level	Proficiency assessed by
PSO1	**Professional Skills:** 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..	S	Lectures, Assignments

Program Specific Outcomes		Level	Proficiency assessed by
PSO2	**Problem-Solving Skills:** 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.	S	Projects
PSO3	**Successful Career and Entrepreneurship:** 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..	S	Guest Lectures

N - None **S - Supportive** **H - Highly Related**

IX. SYLLABUS

UNIT-I

Introduction: Concept of control systems- Open Loop and closed loop and their differences-Different examples of control systems –classification of control systems, feed –back characteristics, Effects of feedback. Mathematical models – Differential equations, Impulse Response and transfer function

Transfer function representation: Block diagram representation of systems considering electrical systems as examples. Block diagram algebra – Representation by Signal flow graph - Reduction using Mason's gain formula.

UNIT-II

Time response analysis: Standard test signals - Time response of first order systems – Characteristic Equation of Feedback control systems, Transient response of second order systems - Time domain specifications – Steady state response - Steady state errors and error constants – Effects of proportional derivative, proportional integral systems

UNIT-III

Stability analysis in s-domain: The concept of stability – Routh's stability criterion – qualitative stability and conditional stability – limitations of Routh's stability.

Root locus Technique: The root locus concept - construction of root loci-effects of adding poles and zeros to G(s) H(s) on the root loci.

UNIT-IV

Frequency response analysis: Introduction, Frequency domain specifications-Bode diagrams-Determination of Frequency domain specifications and transfer function from the Bode Diagram-Phase margin and Gain margin stability Analysis from Bode .polar plots-nyquist plots-stability analysis compensation technique –lag, lead and lead-lag controllers design in frequency domain, PID controllers

UNIT-V

State space analysis of continuous system: concept of state, state variables and state model, derivation of state models from block diagrams, diazotization-solving the time invariant state equation –state transition matrix and its properties –concept of controllability and observability.

Text books:

1. Control systems by Nagoorkani by RBA publication
2. Modern control engineering by K.Ogata,prentice hall

References:

1. Control system engineering by I.J.nagarath and M.Gopal,new age
2. Control system –A.Anand Kumar

X. COURSE PLAN

At the end of the course, the students are able to achieve the following course learning outcomes

Lecture no.	Learning objectives	Topics to be covered	Reference
1	Introduction	To understand the control system	T1:1.1
2-3	Introduction to system and control systems	To understand the Concepts of Control Systems, Open Loop and Closed loop control systems and their differences	T1:1.2
4	Differences of control system	To study the Differences of open and closed control system	T1:1.3
5	Different examples of control systems	To study the Different examples of closed control system	T1:1.4-1.7
6	classification of control systems	To understand classification of control systems	T1:1.1
7	feed –back characteristics, Effects of feedback	To understand feed –back characteristics ,Effects of feedback	T1:1.3
8	Differential equations, Impulse Response and transfer function	To understand the Differential equations, Impulse Response and transfer function of a Control Systems.	T1:1.4
9	translational and rotational mechanical system	To understand and analyze the translational and rotational mechanical system	T1:1.10
10-11	Block diagram representation of systems considering electrical systems as examples	To understand the Block diagram representation of systems considering electrical systems as examples	T1:1.11
12-13	Block diagram algebra	To understand and analyze the Problems on Block diagram algebra	T1:1.11
14-15	Representation by Signal flow graph - Reduction using Mason's gain formula.	To understand and analyze the Signal flow graph - Reduction using Mason's gain formula.	T1:1.12
16	Introduction	To understand the Time response analysis of system	T1:3.1
17-19	Time response of first order systems	To understand the Time response of first order systems	T1:3.5
20-21	Characteristic Equation of Feedback control systems	To understand the Characteristic Equation of Feedback control systems	T1:3.6
22-24	Transient response of second order systems - Time domain specifications	To understand and analyze Transient response of second order systems - Time domain specifications	T1:3.7
25-26	Steady state response - Steady state errors and error constants	To understand the Steady state response - Steady state errors and error constants	T1:3.10,3.11
26-28	Effects of proportional derivative, proportional integral systems.	To understand the Effects of proportional derivative, proportional integral systems.	T1:3.8
29	Introduction	To understand The concept of stability	T1:4.1

30-35	Routh's stability criterion – qualitative stability and conditional stability	Routh's stability Routh's stability criterion	T1:5.3
36	limitations of Routh's stability	To understand the limitations of Routh's stability	T1:5.3
37	Introduction	To understand The root locus concept	T1:5.8
38-42	Construction of root loci-effects of adding poles and zeros to G(s) H(s) on the root loci.	To understand and analyze Root locus and problems	T1:5.8
43	Introduction	To understand the frequency response analysis	T1:4.1
44-45	Frequency domain specifications	To understand the Frequency domain specifications expressions	T1:4.2
46-48	Determination of Frequency domain specifications and transfer function from the Bode Diagram-Phase margin and Gain margin stability Analysis from Bode Plots.	To understand and analyze transfer function from the Bode Diagram-Phase margin and Gain margin and different problems	T1:4.3,4.4,4.5 ,4.6
49	polar plots-nyquits plots-stability analysis	To understand polar ,nyqits plots	T1 :4.7
50-51	compensation technique –lag, lead and lead-lag controllers design in frequency domain	To analyse compensation technique	T1:4.8
51-53	PID controllers	To understand pid controller	T1:4.9
54	concept of state, state variables and state model	To understand concept of state variable	R2:10.1 to20
55-59	derivation of state models from block diagrams	To understand state model	R2:10.1to 20
60-62	diazotization-solving the time invariant state equation	To understand diazotization	R2:10.1to 20
63-66	state transition matrix and its properties – concept of controllability and observability.	To understand state transition matrix and its properties	R2:10.1to20

XI. MAPPING COURSE OBJECTIVES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Objectives	Program Outcomes	Program Specific Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	H	S	H	S		S	H		S			S	S	S	
2		S	H	S							S	S		S	S
3	H		H	S		S			S	S	S	S	S	S	S
4	H			S		S				S		S	S		S
5	H	S	H	S		S	H		S			S	S	S	
6		S	H	S							S	S		S	S

S – Supportive **H - Highly Related**

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

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1		S				S	H		S	S	S		S	S	S
2	H	S	H	S		S	H		S			S		S	S
3		S	H	S							S	S	S		S
4	H		H	S		S			S	S	S	S		S	S
5	H			S		S				S		S	S		S
6		S				S	H		S	S	S		S	S	S
7	H	S					H			S	S	S		S	S
8		S	H	S		S	H					S	S		S
9	H	S	H	S		S			S		S			S	
10			H	S		S			S	S	S	S	S	S	S
11	H			S					S	S				S	S
12		S				S	H			S	S		S		S
13	H	S				S	H		S	S		S		S	
14		S	H	S		S	H		S		S	S	S	S	S

S – Supportive **H - Highly Related**

Prepared by: Mr. N. Nagaraj, Assistant Professor, Department of ECE

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