COURSE TITLE	**CONTROL SYSTEM ENGINEERING**
COURSE CODE	**01EE1403**
COURSE CREDITS	**5**

Objective:

1 To develop comprehensive knowledge of feedback control systems, mathematical modelling, and stability analysis in time and frequency domain.

2 To develop comprehensive knowledge of feedback control systems, mathematical modelling, and stability analysis in time and frequency domain

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

1 Describe the concept and need of feedback control system.

2 Derive mathematical model of various control systems.

3 Assess the performance of linear control systems in time and frequency domain.

4 Demonstrate the effect of controllers on the performance of control systems.

5 Derive state space model of electrical systems.

Pre-requisite of course: Knowledge of ordinary differential equations and Laplace transform

Teaching and Examination Scheme

Theory Hours	Tutorial Hours	Practical Hours	ESE	IA	CSE	Viva	Term Work
4	0	2	50	30	20	25	25

Contents : Unit	Topics	Contact Hours
1	**Introduction to Control System** Terminology - plant, process, system, disturbances, controlled variable, manipulated variable etc., Block diagram of basic control system, application areas with examples. Classifications of control systems.	4
2	**Mathematical modelling of systems** Differential equations of physical systems,, Linear Approximations of physical systems, The Laplace Transform, , The Transfer function of linear Systems. Force voltage and Force current analogy, Block Diagram reduction technique, signal-flow graph, construction of signal flow graph, use of Mason' s gain formula to determine the transfer function.	12

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Contents : Unit	Topics	Contact Hours
3	**Time Response Analysis** Standard test signals, steady state error, steady-state response analysis of first and second order systems, transient response specifications, transient response analysis., Effects of Proportional, Derivative, Integral and Rate-feedback controllers on system response., Stability-Concept of stability, absolute stability and relative stability,, necessary conditions for stability, Routh stability criterion, stability analysis using Routh criteria, limitation of Routh criterion,, concept of root locus, step by step procedure for root loci, stability analysis using root-locus.	15
4	**Frequency Response Analysis** Introduction to Frequency response analysis, frequency domain design specifications, , stability analysis using of Bode plot and polar plot, Nyquist stability criterion.	13
5	**Introduction to Compensators** Introduction, types of Compensation, Lead Compensator,, Lag Compensator, Lag-Lead Compensator,, Effects of compensator on frequency response	6
6	**State space analysis** State space representation, state variables, state, state vector,, state space, formulation of state space equations for electrical systems, Concept of controllability and observability, , Transfer function from state variable model.	6
Total Hours		**56**

Suggested List of Experiments:

Contents : Unit	Topics	Contact Hours
1	**Experiment No. 01** To familiarize with basic control system commands in MATLAB/SIMULINK.	2
2	**Experiment No. 02** To analyse the effect of nature of input on Type-0, 1 and 2 systems.	2
3	**Experiment No. 03** To obtain step and impulse response of first and second-order systems.	2
4	**Experiment No. 04** To analyse the effect of damping on second order system response.	2
5	**Experiment No. 05** To analyse the effect of P, PD, PI and PID controller on time response.	2
6	**Experiment No. 06** To obtain transfer function and step response of field and armature controlled DC Motor.	2

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Suggested List of Experiments:

Contents : Unit	Topics	Contact Hours
7	**Experiment No. 07** To carry out stability analysis of time-domain system using root-locus technique.	2
8	**Experiment No. 08** To carry out stability analysis of frequency-domain system using bode plot.	2
9	**Experiment No. 09** To perform flow and level control using PID controller.	2
10	**Experiment No. 10** To analyse the effect of lag and lead compensator on frequency response.	2
11	**Experiment No. 11** To obtain state-space model for electrical systems.	2
12	**Experiment No. 12** Transient response analysis of 3rd Order System	2
Total Hours		**24**

Textbook :

1 Control Systems: Principles and Design, M. Gopal, McGraw Hill Education, 1997
2 Control Systems Engineering, J. Nagrath and M. Gopal, New Age International, 2009
3 Control Systems, A. Anand Kumar, PHI Learning Private Limited, 2014

References:

1 Automatic Control System, Automatic Control System, B. C. Kuo, Prentice Hall, 1995
2 Modern Control Engineering, Modern Control Engineering, K. Ogata, Prentice Hall, 1991
3 Control System Engineering, Control System Engineering, Norman S. Nise, Wiley Publication, 2015
4 Control System Engineering, Control System Engineering, S. K. Bhattacharya, Pearson, 2008
5 Control Systems, Control Systems, Ashfaq Hussain, Haroon Ashfaq, Dhanpat Rai & Co, 2009

Suggested Theory Distribution:

The suggested theory distribution as per Bloom's taxonomy is as follows. This distribution serves as guidelines for teachers and students to achieve effective teaching-learning process

Distribution of Theory for course delivery

Remember / Knowledge	Understand	Apply	Analyze	Evaluate	Higher order Thinking / Creative
10.00	30.00	35.00	15.00	10.00	0.00

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DR. RAJENDRASINH BAHADURSINH JADEJA
Digitally signed by (Name of Dean/ Principal)

Instructional Method:

1 he course delivery method will depend upon the requirement of content and need of students. The teacher in addition to conventional teaching method by black board, may also use any of tools such as demonstration, role play, Quiz, brainstorming, case studies etc.

2 The internal evaluation will be done on the basis of continuous evaluation of students in the class-room.

3 Practical examination will be conducted at the end of semester for evaluation of performance of students in classroom.

4 Students will use supplementary resources such as online videos

Supplementary Resources:

1 https://onlinecourses.nptel.ac.in/noc20_ee90/preview

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