B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER - VI

CONTROL SYSTEMS (Core Subject)

Subject Code	15EE61	IA Marks	20
Number of Lecture Hours/Week	04	Exam Hours	03
Total Number of Lecture Hours	50	Exam Marks	80

Credits - 04

Course objectives:

- To define a control system
- To explain the necessity of feedback and types of feedback control systems.
- To introduce the concept of transfer function and its application to the modeling of linear systems.
- To demonstrate mathematical modeling of control systems.
- To obtain transfer function of systems through block diagram manipulation and reduction
- To use Mason's gain formula for finding transfer function of a system
- To discuss transient and steady state time response of a simple control system.
- To discuss the stability of linear time invariant systems and Routh - Hurwitz criterion
- To investigate the trajectories of the roots of the characteristic equation when a system parameter is varied.
- To conduct the control system analysis in the frequency domain.
- To analyze stability of a control system using Nyquist plot.
- To discuss stability analysis using Bode plots.
- To determine the controller or compensator configuration and parameter values relative to how it is connected to the controlled process given the design specifications.■

Module-1		**Teaching Hours**
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.■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
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.■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-3		
Time Domain Analysis: Standard test signals, time response of first order systems, time response of second order systems, steady state errors and error constants, types of control systems. **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. ■		**10**
Revised Bloom's Taxonomy Level	L_2 – Understanding, L_3 – Applying, L_4 – Analysing, L_5 – Evaluating.	
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 – 2^{nd} order systems only. **Bode plots:** Basic factors G(iw)/H(jw), General procedure for constructing bode plots, computation of gain margin and phase margin. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	

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15EE61 CONTROL SYSTEMS (Core Subject) (continued)

Module-5	**Teaching Hours**
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.■	**10**
Revised Bloom's Taxonomy Level L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	

Course outcomes:

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

- Discuss the effects of feedback and types of feedback control systems.
- Evaluate the transfer function of a linear time invariant system.
- Evaluate the stability of linear time invariant systems.
- Apply block diagram manipulation and signal flow graph methods to obtain transfer function of systems.
- Demonstrate the knowledge of mathematical modeling of control systems and components
- Determine transient and steady state time response of a simple control system.
- Investigate the performance of a given system in time and frequency domains.
- Discuss stability analysis using Root locus, Bode plots and Nyquist plots.
- Determine the controller or compensator configuration and parameter values relative to how it is connec ted to the controlled process given the design specifications.

Graduate Attributes (As per NBA)

Engineering Knowledge, Problem analysis, Modern Tool Usage, Life-long Learning.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks. Each full question consisting of 16 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook

1	Control Systems	Anand Kumar	PHI	2nd Edition, 2014

ReferenceBooks

1	Automatic Control Systems	FaridGolnaraghi, Benjamin C. Kuo	Wiley	9th Edition, 2010
2	Control Systems Engineering	Norman S. Nise	Wiley	4th Edition, 2004
3	Modern Control Systems	Richard C Dorf et al	Pearson	11th Edition, 2008
4	Control Systems, Principles and Design	M.Gopal	McGaw Hill	4th Edition, 2012
5	Control Systems Engineering	S. Salivahanan et al	Pearson	1st Edition, 2015