Course code	Course Name	L-T-P-Credits	Year of Introduction
IC301	CONTROL ENGINEERING - 1	3-1-0-4	2016

Prerequisite: Nil

Course Objectives

- To study the time and frequency domain analysis of control systems
- To study the root locus analysis of control systems
- To study the stability analysis of control systems
- To study the techniques to design controllers

Syllabus

Transfer function – Block diagram – signal flow graph. Time domain analysis - transient response – steady state response. Stability – Routh's stability criterion – root locus analysis. Frequency domain analysis – frequency domain specifications – Polar plot – Nyquist stability criterion – Bode plots – Nichols chart. Design of controllers – root locus method – Controller design using Bode diagrams

Expected Outcome

After the completion of the course, students will be able to

i. Analyse control systems in time domain and frequency domain
ii. Plot the root locus of systems
iii. Determine the stability of systems by Routh's criterion, Nyquist criterion and Bode plots
iv. Design controllers using root locus and Bode plots.

Text Books

1. K. Ogata , *Modern Control Engineering*, Prentice Hall of India.
2. Nagrath & Gopal, *Control System Engineering*, New Age Int. (P) Ltd.

Reference Books

1. B.C.Kuo, *Automatic Control System* , Prentice Hall of India.
2. George.J. Thaler, *Automatic Control System* , Jaico Publishing House.
3. Gopal, *Digital Control and State Variable Methods*, Tata McGraw Hill.
4. R.C. Dorf and R. H. Bishop , *Modem Control Systems* , Pearson Education

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	Introduction–History and trends - Principles of automatic control- feedback systems – Transfer function – Block diagram representation – Block diagram and Transfer function of a typical first order system - Block diagram and transfer function of a typical second order system.	4	15%
	Block diagram reduction techniques Signal flow graphs – Masons' gain formula. Effects of feedback - disturbance rejection, stability, bandwidth, Reduction of parameter variations	4	

II	Time Domain Analysis -Time response – transient and steady state response. Standard test signals and their application in system analysis. Open loop and Closed loop Transfer functions. Type and order of systems. Block diagram and Transfer function of a position control system - block diagram and transfer function of a speed control system. Response of First order systems to impulse, step and ramp inputs.	8	**15%**
FIRST INTERNAL EXAM			
III	Response of second order systems to impulse, step and ramp inputs. Analysis of under damped second order system response to unit step input in detail – time domain specifications and their role in transient response. Steady state response – steady state error- static & dynamic error coefficients. Effect of addition of poles and zeros on system performance. Higher order systems – Dominant closed loop poles	8	**15%**
IV	Stability of linear systems - Definitions. Characteristic Polynomial and Characteristic Equation. General stability criterion with reference to s plane. Routh's criterion of stability - absolute and relative stability	3	**15%**
	Root locus -construction of root locus – effect of addition of poles and zeros on root locus.	5	
SECOND INTERNAL EXAM			
V	Frequency Domain Analysis - Frequency response representation – Sinusoidal Transfer function – Second order system and frequency domain specifications – correlation of time and frequency domain specifications. Stability in Frequency Domain. Frequency response plots. Nyquist plot and Nyquist stability criterion. Polar plots. Relative stability- Gain Margin and Phase Margin. Logarithmic plots – Bode magnitude and Phase plots. Stability from Bode plots. All pass, minimum phase and non-minimum phase systems – Transportation lag.	9	**20%**
	Closed loop frequency response - M & N circles – Nichol's chart.	3	
VI	Introduction to design – compensation techniques – P, PI, PD and PID control - Lead, Lag and Lead - Lag compensation using RC network. Design of Lead, Lag and Lead-Lag compensators in time domain using root locus.	7	**20%**
	Design of Lead, Lag and Lead-Lag compensators in frequency domain using Bodediagrams. *Use of Nichols charts.*	5	
END SEMESTER EXAM			

QUESTION PAPER PATTERN:

Maximum Marks: 100 Exam Duration: 3 Hours

Part A

Answer any two out of three questions uniformly covering Modules 1 and 2. Each question carries 15 marks and can have not more than four sub divisions. (15 x 2 = 30 marks)

Part B

Answer any two out of three questions uniformly covering Modules 3 and 4. Each question carries 15 marks and can have not more than four sub divisions. (15 x 2 = 30 marks)

Part C

Answer any two out of three questions uniformly covering Modules 5 and 6. Each question carries 20 marks and can have not more than four sub divisions. (20 x 2 = 40 marks)