Course code	Course name	L-T-P-Credits	Year Of Introduction
AE464	NON-LINEAR CONTROL SYSTEM	3-0-0-3	2016

Prerequisite : AE301 Control system

Course objectives

- To familiarize the modelling of simple mechanical systems.
- To analyse stability of nonlinear control systems

Syllabus

Linear vs non-linear system - Common Nonlinearities in control systems - mass spring system - method of iscoclanes- phase plane analysis of linear systems- phase plane analysis of non-linear systems- bendixon theorems - Describing Function Fundamentals -Describing functions of common nonlinearities - Concepts of Stability- Linearization and Local Stability - Lyapunov's Direct Method - Generation of Lyapunov functions -Popov's stability criterion - Non-Linear control system design-stabilisation problems-tracking problems - Issues in constructing non-linear controllers- available methods of non-linear control design.

Expected outcome

- At the end of the semester students must be able to understand and analyse the different behaviour of system performances and Stability technique.

Text Books

1. Jean Jacques Slotine and Weiping Li , "Applied Nonlinear Control", Prentice Hall Inc., 1991.
2. H. K. Khalil., "Nonlinear Systems", Pearson Education, 3rd Ed.
3. M Gopal "Digital Control and State Variable Methods", Tata McGraw-Hill Ltd, New Delhi, 2003.
4. Nagoor Kani, "Advanced Control System", Rba Publications

Course Plan

Module	Contents	Hours	Semester Exam Marks
I	Introduction: Linear vs non-linear system- non-linear systems and equilibrium points- non–linear system behavior-examples-Common Nonlinearities in control systems-Autonomous and non-autonomous systems-modelling of simple pendulum- mass spring system-analysis and design of nonlinear system.	7	15%
II	Phase Plane Analysis: Singular points-construction of phase portraits- method of iscoclanes- phase plane analysis of linear systems- phase plane analysis of non-linear systems- local behaviour of non-linear systems-limit cycles- Stability- poincare- bendixon theorems.	7	15%
	FIRST INTERNAL EXAMINATION		
III	Describing Function: Describing Function Fundamentals - Describing functions of common nonlinearities-hysteris, backlash, relay, deadzone, saturation and combined effects-stability analysis and limit cycles.	7	15%
IV	Stability of nonlinear systems-Lyapunov theory (review)-autonomous and non-autonomous systems equilibrium points, Stability in the sense of Lyapunov, asymptotic stability and exponential stability, Linearization and local	7	15%

	stability, Lyapunov's direct method, positive definite functions and Lyapunov functions, Lyapunov theorem for local stability and global stability		
SECOND INTERNAL EXAMINATION			
V	Analysis based on Lyapunov's direct method-LTI systems-Krasovskii's method, Variable gradient method for constructing Lyapunov functions-simple examples, Popov's stability criterion. Stability of non-autonomous systems (basic concepts only)- Lyapunov's direct method – simple problems.	7	20%
VI	Non-Linear control system design-stabilisation problems-tracking problems-relations between stabilization and tracking problems-desired behaviour of nonlinear systems-Issues in constructing non-linear controllers- available methods of non-linear control design.	7	20%
END SEMESTER EXAMINATION			

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 together. Each question carries 15 marks and may 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 together. Each question carries 15 marks and may 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 together. Each question carries 15 marks and may have not more than four sub divisions.

(20 x 2 = 40 marks)