SEMESTER S7

NON-LINEAR CONTROL

Course Code	**PERUT742**	**CIE Marks**	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	**ESE Marks**	60
Credits	3	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	PCRUT601 Robotic Control Systems	**Course Type**	Theory

Course Objectives:

1. To understand the behavior of nonlinear system
2. To familiarize the analysis of nonlinear system with various methods

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction: Characteristics of non-linear systems - Methods of analysis – Classifications of nonlinearities – Common physical nonlinearities – Saturation or limiter – Deadzone or Threshold – Types of relays - Types of springs – Backlash in Gears – Inherent nonlinearity. Linearisation of Nonlinear system - Autonomous and non autonomous systems-modelling of simple pendulum- mass spring system.	9
2	**Phase plane analysis** Phase Plane Analysis: Singular points- Phase portraits – Analytical method for the construction of Phase trajectories – Graphical method f construction of Phase trajectory – Isoclines Method – Analysis and classification of singular points - Local behaviour of nonlinear systems - Limit cycles on phase plane - Stability- poincare- bendixon theorems.	9
3	**Describing function analysis** Describing Function: Definition - Describing Function Analysis- Describing functions of Typical nonlinearities- Ideal Relay – Relay with deadzone – Simple deadzone – Saturation or Limiter	9

KTU SPECIAL

	Closed loop stability using describing function- Stability of limit cycles – Accuracy of describing function analysis - Relative stability from describing from describing function.	
4	**Stability of the system- Lyapunov Stability Theory** Stability of nonlinear systems- Concept - equilibrium points- stability in small and stability in large- Lyapunov's stability definitions – Localisation and stability in the small - Stability by the method of Lyapunov – First methd of Lyapunov- Concept of Lyapunov's stability theorems - Sign definiteness of scalar function Lyapunov stability theorems - Stability of nonlinear system by method of Lyapunov – Krasovskii' theorem- Variable gradient method of generating Lyapunov function	**9**

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

KTU SPECIAL

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand nonlinear system behaviour	**K2**
CO2	Analyse nonlinear system using phase plane method	**K3**
CO3	Understand and apply describing function method for analysing nonlinear system	**K3**
CO4	Analyse the stability of nonlinear system using Lyapunov method	**K3**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2										2
CO2	3	2	2	2								2
CO3	3	2	2	2								2
CO4	3	2	2	2								2

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation*

KTU SPECIAL

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Nonlinear systems	H. K. Khalil	Prentice Hall	3rd Edition, 2002.
2	Applied Nonlinear Control	Jean Jacques Slotine, Weiping Li	Prentice Hall Inc.	1991
3	Nonlinear Systems; Analysis, Stability and Control	Shankar Sastry	Springer	1999
4	Advanced Control System	Nagoor Kani	Rba Publication	

KTU SPECIAL Downloaded from ktuspecial.in · PERUT742 · 3/4

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Nonlinear systems analysis	M. Vidyasagar	Society of Industrial and Applied Mathematics	2nd Edition,2002
2	Nonlinear Control Systems, Analysis and Design	H. Marquez	Wiley	2003
3	Nonlinear Control Systems	A. Isidori,	Springer	3rd Edition, 1995
4	Nonlinear Differential Equations and Dynamical Systems	F. Verhulst	Springer	2nd Edition, 1996.

KTU SPECIAL