Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/ Practical	Tutorial	Total
EXC 404	Principles of Control Systems	04	--	--	04	--	--	04

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
EXC 404	Principles of Control Systems	20	20	20	80	--	-	--	100

Prerequisite Topics*:*
Differential equations; Laplace transforms and Matrices.

Course Objectives:
Objectives of this course are:

1. To study the fundamental concepts of Control systems and mathematical modeling of the system.
2. To study the concept of time response and frequency response of the system.
3. To study the basics of stability analysis of the system and design of simple controllers

Course Outcome:

1. Students will be able to derive the mathematical model of different type of the systems.
2. Students will understand the basic concepts of control system.
3. Students will understand the analysis of systems in time and frequency domain.
4. Students will be able to apply the control theory to design the conventional PID controller widely used in the industries.

Module No.	Topics	Hrs.
1.	**Introduction to control system analysis**	06
	1.1 Introduction: Open loop and closed loop systems; feedback and feedforward control structure; examples of control systems.	
	1.2 Modeling: Types of models; Impulse response model; State variable model; Transfer function model.	
	1.3 Dynamic Response: Standard test signals; Transient and steady state behavior of first and second order systems; Steady state errors in feedback control systems and their types.	
2	**Mathematical modeling of systems**	08
	2.1 Transfer function models of various systems: Models of mechanical systems; Models of electrical systems; Models of thermal systems.	
	2.2 Manipulations: Block diagram reduction; Signal flow graph and the Mason's gain rule.	

3	**State Variable Models**	12
	3.1 State variable models of various systems: State variable models of mechanical systems; State variable models of electrical systems; State variable models of thermal systems.	
	3.2 State transition equation: Concept of state transition matrix; Properties of state transition matrix; Solution of homogeneous systems; solution of non-homogeneous systems.	
	3.3 Controllability and observability: Concept of controllability; Controllability analysis of LTI systems; Concept of observability; Observability analysis of LTI systems using Kalman approach.	
4	**Stability analysis in time domain**	06
	4.1 Concepts of Stability: Concept of absolute, relative and robust stability; Routh stability criterion.	
	4.2 Root locus analysis: Root-locus concepts; General rules for constructing root-locus; Root-locus analysis of control systems.	
5	**Stability analysis in frequency domain**	10
	5.1 Introduction: Frequency domain specifications, Response peak and peak resonating frequency; Relationship between time and frequency domain specification of system; Stability margins.	
	5.2 Bode plot: Magnitude and phase plot; Method of plotting Bode plot; Stability margins on the Bode plots; Stability analysis using Bode plot.	
	5.3 Nyquist Criterion: Polar plots, Nyquist stability criterions; Nyquist plot; Gain and phase margins.	
6	**Compensators and controllers**	10
	6.1 Compensators: Types of compensation; Need of compensation; Lag compensator; Lead compensator.	
	6.2 Controllers: Concept of ON/OFF controllers; Concept of P, PI, PD and PID Controllers.	
	6.3 Advances in Control Systems: Introduction to Robust Control, Adaptive control and Model predictive control.	
	Total	**52**

Recommended Books

1. I. J. Nagrath, M. Gopal, Control Systems Engineering, New Age International, Fifth Edition, 2012.
2 Dhanesh N. Manik, Control Systems, Cengage Learning, First Edition, 2012.
3. M. Gopal, Control Systems: Principle and design, Tata McGraw Hill, First Edition, 1998
4. Richard C. Dorf and Robert H. Bishop, Modern Control System, Pearson, Eleventh Edition, 2013.
5. Norman S. Nice, Control Systems Engineering, John Wiley and Sons, Fifth Edition, 2010
6. Rajeev Gupta, Control Systems Engineering, Wiley India, First Edition, 2011.

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3: Question No.1 will be compulsory and based on entire syllabus. 4:
Remaining question (Q.2 to Q.6) will be set from all the modules. 5:
Weightage of marks will be as per Blueprint.