Academic Course Description

BHARATH UNIVERSITY
Faculty of Engineering and Technology
Department of Electronics and Communication Engineering

BEI601- Control Systems

Fifth Semester, 2015-16 (even Semester)

Course (catalog) description

System modeling, simulation, analysis and controller design. Differential equations, transfer function representation, block diagrams and signal flows. System dynamic properties in time and frequency domains, performance specifications. Stability analysis: Routh-Hurwitz criterion, Root Locus method, Bode gain and phase margins, Nyquist criterion. Bode plot and polar plot, Classical controller design in time and frequency domain: lead, lag, lead-lag compensation, rate feedback, PID controller.

Compulsory/Elective course : Compulsory for ECE students

Credit hours **:** 4 credits

Course Coordinator **: Mr.R.Mohanraj**, Asst. Professor, Department of ECE

Instructor(s) **: Mr.Srinivasan**, Asst. Professor, Department of ECE

Name of the instructor	Class handling	Office location	Office phone	Email (domain: @bharathuniv.ac.in)	Consultation
Mr.R.Mohanraj	Third year ECE	SA006		mohanraj.ece @bharathuniv.ac.in	9.00-9.50 AM
Mr.Srinivasan	Third year ECE	SA006		Srinivasan.etc @bharathuniv.ac.in	12.45-1.15 PM

Relationship to other courses

Pre-requisites	:	BPH101 Engineering Physics –I, BMA101 Mathematics –I
Assumed knowledge	:	The students will have a physics and mathematics background obtained at a high School (or equivalent) level. In particular, working knowledge of basic mathematics Including differentiation, integration and probability theories are assumed.
Following courses	:	Nil

Syllabus Contents

UNIT 1 CONTROL SYSTEM MODELLING **12 HOURS**

System concept. Differential equations. Transfer functions. Introduction to model based design-Modelling of electric systems, Translational and rotational mechanical systems, simple Electro - mechanical systems. Block diagram representation of systems. Block Diagram reduction methods. Closed loop transfer function, determination of Signal flow graphs. Mason's gain formula. Examples.Need for modulation, Amplitude Modulation System, Single Tone & Multiple Tone Amplitude Modulation, Power Relation, Generation of Amplitude Modulation – Linear Modulation – Collector Modulation method Non-linear Modulation – Square law Modulator, Product Modulator, Switching Modulator - Demodulation of Amplitude Modulation – Envelope Detector, Coherent Detector, VSB, Performance comparison of various Amplitude Modulation System.

UNIT 2 TIME RESPONSE ANALYSIS **12 HOURS**

First Order Systems. Impulse and Step Response analysis. Second Order system Analysis. Steady state error. Error Coefficients and Generalized error series. Principle of PI, PD and PID Compensation. Servo Motor, Synchros & Stepper Motor-analysis using Matlab.

UNIT 3 STABILITY IN TIME DOMAIN **12 HOURS**

Stability Analysis. Routh - Hurwitz Criterion. Root locus Method. Construction of root, locus diagrams. Stability Study. Application of root locus diagram-analysis using Matlab.

UNIT 4 STABILITY IN FREQUENCY DOMAIN **12 HOURS**

Frequency response analysis. Frequency domain specifications . Polar plot, Bode's Plot, Magnitude - Phase plot, Constant M and N Circles. Nichol's Chart Nyquist Stability Criterion. Relative Stability - gain Margin and Phase margin, determination from Polar plot, Bode's Plot and Magnitude – Phase Plot. Use of Nichol's Chart in system analysis to determine relative stability, Bandwidth, Resonance peak and resonance frequency- Analysis using Matlab.

UNIT 5 COMPENSATION TECHNIQUES **12 HOURS**

Cascade and feedback compensation. Lag, Lead and Lag- lead Compensation. Design of Cascade Compensators - Using Bode's Plot.

TOTAL 60 HOURS

Text book(s) and/or required materials

TEXT BOOKS

T1. J.Nagrath and M.Gopal, "Control System Engineering", New Age International Publishers,5th Edition,2007.

REFERENCES

R1. Benjamin.C.Kuo, "Automatic control systems", Prentice Hall of India, 7thEdition, 1995.

R2 .M.Gopal, "Control System– Principles and Design",TataMcGrawHill, 2ndEdition,2002.

R3. Schaum"sOutlineSeries, "FeedbackandControlSystems" Tata McGraw-Hill,2007.

R4. John J.D"Azzo &ConstantineH.Houpis, "LinearControl System Analysisand Design"",Tata McGraw-Hill,Inc., 1995.

R5. www.electrical4u.com

Computer usage: Nil

Professional component

General	-	0%
Basic Sciences	-	0%
Engineering sciences & Technical arts	-	0%
Professional subject	-	100%

Broad area : | Signal Processing | Electronics | Embedded

Test Schedule

S. No.	Test	Tentative Date	Portions	Duration
1	Cycle Test-1	February 2nd week	Session 1 to 20	2 Periods
2	Cycle Test-2	March 2nd week	Session 21 to40	2 Periods
3	Model Test	April 2nd week	Session 1 to 60	3 Hrs
4	University Examination	TBA	All sessions / Units	3 Hrs.

Mapping of Instructional Objectives with Program Outcome

To study control problem, control system dynamics and feedback principles. To study time response of first and second order systems and basic state variable analysis and to do simple problems. To study the concept of stability and criteria for stability and to do simple problems. To study the frequency response through polar plots and Bode plots and Nyquist stability criteria and to do simple problems.	**Correlates to program outcome**		
	H	M	L
1. Outline the development of mathematical models to represent systems and their representation by transfer functions	a	f,l,j	g
2. Discuss the transient and steady state response of control systems	c	a,e,d	i
3. Practice frequency domain plots (Bode and Polar)	d	a	h
4. Analyze performance of control systems	e,j	a,e,g	i
5. Design compensation networks.	a	i	b
6. Design the different types of compensators	f		

H: high correlation, M: medium correlation, L: low correlation

Draft Lecture Schedule

Session	Topics	Problem Solving (Yes/No)	Text/Chapter
UNIT I CONTROL SYSTEM MODELLING			
1.	System Concept	No	[T1] Chapter -1, [R1]Chapter-2,3
2.	Differential equations	Yes	
3.	Transfer functions.	Yes	
4.	Modelling of electric systems,	Yes	
5.	Translational mechanical systems	Yes	
6.	Rotational mechanical systems	Yes	
7.	simple Electro - mechanical systems.	Yes	
8.	Block diagram representation of systems	Yes	
9.	Block Diagram reduction methods	Yes	
10.	Closed loop transfer function	Yes	
11.	Determination of Signal flow graphs	Yes	
12.	Mason's gain formula with Examples	Yes	
UNIT II TIME RESPONSE ANALYSIS			
13.	First Order Systems	Yes	[T1] Chapter -2, [R1]Chapter-4,5
14.	Impulse and Step Response analysis	Yes	
15.	Second Order system Analysis	Yes	
16.	Steady state error	Yes	
17.	Steady state error with input signal	Yes	
18.	Error Coefficients	Yes	
19.	Generalized error series	Yes	
20.	Principle of PI, PD Compensation	Yes	
21.	PID Compensation	Yes	
22.	Servo Motor,	Yes	
23.	Synchros & Stepper Motor	Yes	
24.	analysis using Matlab	Yes	
UNIT III STABILITY IN TIME DOMAIN			
25.	Stability Analysis	Yes	

26.	Definition of Stability analysis	Yes	[T1] Chapter -3, [R2]Chapter-,5
27.	Location of poles on s-Plane for Stability	Yes	
28.	Routh - Hurwitz Criterion	Yes	
29.	Construction of Routh array	Yes	
30.	Routh array Cases	Yes	
31.	Root locus Method	Yes	
32.	Construction of root locus diagrams.	Yes	
33.	Root locus problems	Yes	
34.	Stability Study	Yes	
35.	Application of root locus diagram.	Yes	
36.	Analysis using Matlab	Yes	
UNIT IV	**STABILITY IN FREQUENCY DOMAIN**		
37.	Frequency response analysis	Yes	[T1] Chapter -4, [R2]Chapter-6,7
38.	Frequency domain specifications	Yes	
39.	Polar plot,	Yes	
40.	Bode's Plot Magnitude & Phase plot	Yes	
41.	Constant M and N Circles, Nichol's Chart	Yes	
42.	Nyquist Stability Criterion	Yes	
43.	Relative Stability	Yes	
44.	Gain Margin and Phase margin	Yes	
45.	Determination from Polar plot	Yes	
46.	Use of Nichol's Chart relative stability	Yes	
47.	Bandwidth, Resonance peak resonance frequency.	Yes	
48.	Analysis using Matlab	Yes	
UNIT V	**COMPENSATION TECHNIQUES**		
49.	Cascade and feedback compensation	Yes	[T1] Chapter -5, [R3]Chapter-8,7
50.	Lag Compensation	Yes	
51.	Design of Lag Compensation Using Bode plots	Yes	
52.	Design of Lag Compensation Using root locus	Yes	
53.	Lead Compensation	Yes	
54.	Design of Lead Compensation Using Bode plots	Yes	
55.	Design of Lead Compensation Using root locus	Yes	
56.	Lag- lead Compensation	Yes	
57.	Design of Lag-Lead Compensation Using Bode plots	Yes	
58.	Design of Lag-Lead Compensation Using root locus	Yes	
59.	Design of Cascade Compensators	Yes	
60.	Using Bode's Plot	Yes	

Teaching Strategies

The teaching in this course aims at establishing a good fundamental understanding of the areas covered using:

- Formal face-to-face lectures
- Tutorials, which allow for exercises in problem solving and allow time for students to resolve problems in understanding of lecture material.
- Small periodic quizzes, to enable you to assess your understanding of the concepts.

Evaluation Strategies

Cycle Test – I	-	10%
Cycle Test – II	-	10%
Model Test	-	25%
Attendance	-	5%
Final exam	-	50%

Prepared by: Mr.Mohanraj, Assistant Professor, Department of ECE **Dated :**

Addendum

ABET Outcomes expected of graduates of B.Tech / ECE / program by the time that they graduate:

(a) an ability to apply knowledge of mathematics, science, and engineering

(b) an ability to design and conduct experiments, as well as to analyze and interpret data

(c) an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability

(d) an ability to function on multidisciplinary teams

(e) an ability to identify, formulate, and solve engineering problems

(f) an understanding of professional and ethical responsibility

(g) an ability to communicate effectively

(h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context

(i) a recognition of the need for, and an ability to engage in life-long learning

(j) a knowledge of contemporary issues

(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

Program Educational Objectives

PEO1: Graduates will perform as a successful professional engineer in related fields of Electronics and Communication Engineering.

PEO2: Graduates will pursue higher education and/or engage themselves in continuous professional development to meet global standards.

PEO3: Graduates will work as a team in diverse fields and gradually move into leadership positions.

PEO4: Graduates will understand current professional issues, apply latest technologies and come out with innovative solutions for the betterment of the nation and society.

Course Teacher	Signature
Mr.MOHANRAJ	
Mr.SRINIVASAN	

Course Coordinator	Academic Coordinator	Professor In-Charge	HOD/ECE
(Mr.R.Mohanraj)	( )	(Dr.)	(Dr.M.Sundararajan)