Academic Course Description

BHARATH UNIVERSITY

Faculty of Engineering and Technology

Department of Electrical and Electronics Engineering

BEE501 & CONTROL SYSTEMS

Fifth Semester(Odd Semester)

Course (catalog) description

To provide an introduction to the analysis of linear control systems.This will permit to exploit time domain and frequency domain tools

Compulsory/Elective course **:** Compulsory for EEE students

Credit hours& contact hours : 4 & 60 hours

Course Coordinator : Dr.V.Jayalakshmi

Instructors **:** Dr.V.Jayalakshmi

Name of the instructor	Class handling	Office location	Office phone	Email (domain:@ bharathuniv.ac.in	Consultation
Dr.V.Jayalakshmi	Third year EEE	KS 302	04422290125	Jayalakshmi.eee@ bharathuniv.ac.in	12.30 PM-1.30 PM

Relationship to other courses:

Pre –requisites : BMA101 MATHEMATICS I

Assumed knowledge :basic knowledge in linear differential equation models of simple electrical circuits and Laplace Transform techniques.

Following courses : BEE003 Advanced Control System

Syllabus Contents:

UNIT I SYSTEMS AND THEIR REPRESENTATION 12

Basic elements in control systems – Open and closed loop systems – Electrical analogy of mechanical systems – Transfer function – Synchros – AC and DC servomotors – Block diagram reduction techniques – Signal flow graphs.

UNITII TIME RESPONSE ANALYSIS 12

Test signals – step response of first order and second order systems – time domain specifications – response with P, PI, PID controller – type and order of a system – steady state error and generalized error coefficients.

UNIT III FREQUENCY RESPONSE ANALYSIS 12

Frequency domain specifications – estimation of the specification for a second order system – Bode plot – polar plot — closed loop response from open loop response

UNIT IV STABILITY AND COMPENSATOR DESIGN 12

Definition – characteristics equation – Routh Hurwitz criterian – Nyquist stability criterion – gain margin and phase margin – root locus – compensator design using bode plot-matlab basics for control systems.

UNIT V STATE VARIABLE ANALYSIS 12

Concept of state variables – State models for linear and time invariant Systems – Solution of state and output equation in controllable canonical form – Concepts of controllability and observability– Effect of state feedback.

Text book(s) and/or required materials:

T1: Katsuhiko Ogata, "Modern Control Engineering" 5th Edition, Prentice Hall of India Private Ltd., New Delhi, 2012.

T2: Nagrath I J and Gopal.M., "Control Systems Engineering", 5th Edition, New Age International (P) Ltd, Publishers 2012.

Reference books:

R1:M. Gopal, "Control Systems: Principles and Design", 3rd Edition, McGraw, Hill, 2014

R2: Benjamin C Kuo, "Automatic Control system", Prentice Hall of India Private Ltd., New Delhi 2012.

R3:R.C. Dorf and R.H. Bishop, "Modern Control Systems", 12thEdition, Prentice,Hall, 2010.

R4:http://www.mathworks.com/access/helpdesk/help/toolbox/control/

R5:http://nptel.ac.in/courses/108101037/

Computer usage: MATLAB/SIMULINK

Professional component

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

Broad area : Electrical Machines | Electronics | Power system | **Control**& Instrumentation

Test Schedule

S. No.	Test	Tentative Date	Portions	Duration
1	Cycle Test-1	August 1st week	Session 1 to 24	2 Periods

2	Cycle Test-2	September 2nd week	Session25 to 36	2 Periods
3	Model Test	October 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 provide an introduction to the analysis of linear control systems.This will permit to exploit time domain and frequency domain tools	Correlates to program outcome		
	H	**M**	**L**
CO1: Understand the concept of control system, Electrical analogy of mechanical systems and the use of transfer function models for the analysis of physical systems.	b,d,	a,c, e,l	j,k
CO2: Understand, define different time domain specification parameters	a,b,d ,e	c,l	j,k
CO3: Gain knowledge in various frequency response analysis	a,d,e,	b,c,l ,	j,k
CO4: Understand the methods to analyze the stability of systems design of compensators.	a,d,e	b,c,l	j,k
CO5: Understand the concept of state variable analysis and modeling of the system by the State variable technique.	a,d,e	b,c,l	j,k
H: high correlation, M: medium correlation, L: low correlation			

Draft Lecture Schedule			
S.NO	**Topics**	**Problem solving (Yes/No)**	**Text / Chapter**
UNIT I	**SYSTEMS AND THEIR REPRESENTATION**		
1.	Basic elements in control systems.	No	T1,T2
2.	Open and closed loop systems.	No	
3.	Modeling of mechanical systems	Yes	
4.	Electrical analogy of mechanical systems.	Yes	
5.	Electrical analogy of mechanical systems.	Yes	
6.	Transfer function.	Yes	
7.	Synchros.	No	
8.	AC and DC servomotors.	No	
9.	Block diagram reduction techniques.	Yes	
10.	Block diagram reduction techniques.	Yes	
11.	Signal flow graphs.	Yes	
12.	Signal flow graphs.	Yes	
UNIT II	**TIME RESPONSE ANALYSIS**		
13.	Test signals.	No	T1,T2
14.	Test signals.	No	
15.	Step response of first order and second order systems.	Yes	

16.	Step response of first order and second order systems.	Yes	
17.	Time domain specifications.	No	
18.	Time domain specifications.	Yes	
19.	Response with P, PI, PID controller.	Yes	
20.	Response with P, PI, PID controller.	Yes	
21.	Type and order of a system.	Yes	
22.	Type and order of a system.	Yes	
23.	Steady state error and generalized error coefficients.	Yes	
24.	Steady state error and generalized error coefficients.	Yes	
UNIT III	**FREQUENCY RESPONSE ANALYSIS**		
25.	Frequency domain specifications.	No	T2,R1
26.	Frequency domain specifications.	Yes	
27.	Estimation of the specification for a second order system.	Yes	
28.	Estimation of the specification for a second order system.	Yes	
29.	Estimation of the specification for a second order system.	Yes	
30.	Bode plot.	Yes	
31.	Bode plot.	Yes	
32.	Bode plot.	Yes	
33.	Polar plot.	Yes	

34.	Polar plot.	Yes	
35.	Closed loop response from open loop response.	Yes	
36.	Closed loop response from open loop response.	Yes	
UNIT IV	**STABILITY AND COMPENSATOR DESIGN**		
37.	Definition.	No	R2,T2
38.	Characteristics equation.	Yes	
39.	Characteristics equation.	Yes	
40.	Routh Hurwitz criterion.	Yes	
41.	Routh Hurwitz criterion.	Yes	
42.	Nyquist stability criterion.	Yes	
43.	Nyquist stability criterion.	Yes	
44.	Gain margin and phase margin.	Yes	
45.	Gain margin and phase margin.	Yes	
46.	Root locus.	Yes	
47.	Compensator design using bode plot-matlab basics for control systems.	Yes	
48.	Compensator design using bode plot-matlab basics for control systems.	Yes	
UNIT V	**STATE VARIABLE ANALYSIS**		
49.	Concept of state variables.	No	T1,R3
50.	Concept of state variables.	Yes	
51.	State models for linear and time invariant Systems.	Yes	
52.	State models for linear and time invariant Systems.	Yes	

53.	State models for linear and time invariant Systems.	Yes	
54.	Solution of state and output equation in controllable canonical form.	Yes	
55.	Solution of state and output equation in controllable canonical form.	Yes	
56.	Solution of state and output equation in controllable canonical form.	Yes	T1,R3
57.	Concepts of controllability and observability	Yes	
58.	Concepts of controllability and observability	Yes	
59.	Effect of state feedback.	Yes	
60.	Effect of state feedback.	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.
- Laboratory sessions, which support the formal lecture material and also provide the student with practical construction, measurement and debugging skills.
- Small periodic quizzes, to enable you to assess your understanding of the concepts.

Evaluation Strategies

Cycle Test – I	-	05%
Cycle Test – II	-	05%
Model Test	-	10%
Attendance	-	05%
SEMINAR&ASSIGNMENT	-	05%
Final exam	-	70%

Prepared by: Dr.V.Jayalakshmi **Dated :**

Addendum

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

a) An ability to apply knowledge of mathematics, science, and engineering fundamentals.
b) An ability to identify, formulate, and solve engineering problems.
c) An ability to design a system, component, or process to meet the desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
d) An ability to design and conduct experiments, as well as to analyze and interpret data.
e) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.
f) An ability to apply reasoning informed by the knowledge of contemporary issues.
g) An ability to broaden the education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context.
h) An ability to understand professional and ethical responsibility and apply them in engineering practices.
i) An ability to function on multidisciplinary teams.
j) An ability to communicate effectively with the engineering community and with society at large.
k) An ability in understanding of the engineering and management principles and apply them in project and finance management as a leader and a member in a team.
l) An ability to recognize the need for,and an ability to engage in life-long learning.

.

Program Educational Objectives

PEO1: PREPARATION

Electrical Engineering Graduates are in position with the knowledge of Basic Sciences in general and Electrical Engineering in particular so as to impart the necessary skill to analyze and synthesize electrical circuits, algorithms and complex apparatus.

PEO2: CORE COMPETENCE

Electrical Engineering Graduates have competence to provide technical knowledge, skill and also to identify, comprehend and solve problems in industry, research and academics related to power, information and electronics hardware.

PEO3: PROFESSIONALISM

Electrical Engineering Graduates are successfully work in various Industrial and Government organizations, both at the National and International level, with professional competence and ethical administrative acumen so as to be able to handle critical situations and meet deadlines.

PEO4: SKILL

Electrical Engineering Graduates have better opportunity to become a future researchers/ scientists with good communication skills so that they may be both good team-members and leaders with innovative ideas for a sustainable development.

PEO5: ETHICS

Electrical Engineering Graduates are framed to improve their technical and intellectual capabilities through life-long learning process with ethical feeling so as to become good teachers, either in a class or to juniors in industry.

Course Teacher	Signature
Dr.V.Jayalakshmi	

Course Coordinator ***HOD/EEE***

(Dr.V.Jayalakshmi) ( )