Academic Course Description

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

BEE003 &ADVANCED CONTROL SYSTEM
Sixth Semester, (EVEN Semester)

Course (catalog) description

To provide knowledge on design in state variable form and in phase plane analysis

Compulsory/Elective course: Elective for EEE students

Credit & Contact hours : 3 and 45 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 **:** BEE501 & CONTROL SYSTEMS

Assumed knowledge : Students already have basic knowledge in feedback control systems and mathematic transformation such as Laplace transform.

Syllabus Contents

UNIT I STATE VARIABLE DESIGN 9

Introduction to state Model- effect of state Feedback- Necessary and Sufficient Condition for Arbitrary Pole-placement- pole placement Design- design of state Observers- separation principle- servo design: -State Feedback with integral control.

UNIT II PHASE PLANE ANALYSIS 9

Features of linear and non-linear systems - Common physical non-linearities – Methods of linearization Concept of phase portraits – Singular points – Limit cycles – Construction of phase portraits – Phase plane analysis of linear and non-linear systems – Isocline method.

UNIT III DESCRIBING FUNCTION ANALYSIS 9

Basic concepts, derivation of describing functions for common non-linearities –Describing function analysis of non-linear systems – limit cycles – Stability of oscillations.

UNIT IV OPTIMAL CONTROL 9

Introduction - Time varying optimal control – LQR steady state optimal control – Solution of Ricatti's equation – Application examples.

UNIT V OPTIMAL ESTIMATION 9

Optimal estimation – KalmanBucy Filter-Solution by duality principle-Discrete systems- Kalman Filter-Application examples..

Text book(s) and/or required materials

T1. K. P. Mohandas, "Modern Control Engineering", Sanguine Technical Publishers, 2006.
T2. G. J. Thaler, " Automatic Control Systems", Jaico Publishing House, 1993.
T3. M.Gopal, "Modern Control System Theory", New Age International Publishers, 2002

Reference Books:

R1. William S Levine, "Control System Fundamentals," The Control Handbook, CRC Press, Tayler and Francies Group, 2nd edition, 2011.

R2. AshishTewari, 'Modern Control Design with Matlab and Simulink', John Wiley, New Delhi, 2002.

R3. K. Ogata, 'Modern Control Engineering', 4th edition, PHI, New Delhi, 2002.

R4. T. Glad and L. Ljung,"Control Theory –Multivariable and Non-Linear Methods", Taylor& Francis, 2002.

R5. D.S.Naidu, "Optimal Control Systems" First Indian Reprint, CRC Press, 2009.

R6. http://nptel.ac.in/courses/101108047

Computer usage: MATLAB/SIMULINK

Professional component

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

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

Test Schedule

S. No.	Test	Tentative Date	Portions	Duration
1	Cycle Test-1	February 2nd week	Session 1 to 14	2 Periods

2	Cycle Test-2	March 2nd week	Session 15 to 18	2 Periods
3	Model Test	April 3rd week	Session 19 to 36	3 Hrs
4	University Examination	TBA	All sessions / Units	3 Hrs.

Mapping of Instructional Objectives with Program Outcome

This course introduces the concept of The state-space design methods including state feedback , state observer ,describing function and optimal control	Correlates to program outcome		
	H	**M**	**L**
1. To develop mathematical models and understand the mathematical relationships between the sensitivity functions and how they govern the fundamentals in control systems.	a,d,e,i	B,c,l	G,j,k
2. To understand the phase plane analysis.	a,d,e,i	B,c,l	G,j,k
3. To give basic knowledge in describing function analysis.	a,d,e,i	B,l	G,j,k
4. To study the design of optimal controller	a,d,e,i	B,l	G,j,k
5. To design of optimal estimator including Kalman Filter	A,d,e,i	B,c,l,	G,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	**STATE VARIABLE DESIGN**		
1.	Introduction to state Model	No	T2
2.	effect of state Feedback	No	
3.	Necessary and Sufficient Condition for Arbitrary Pole-placement	Yes	
4.	pole placement Design- design of state Observers	Yes	
5.	separation principle	Yes	
6.	servo design	Yes	
7.	servo design	Yes	
8.	State Feedback with integral control	Yes	
9.	State Feedback with integral control	Yes	
UNIT II	**PHASE PLANE ANALYSIS**		
10.	**Features of linear and non-linear**	No	T2
11.	**Common physical non-linearities**	No	
12.	Methods of linearization Concept of phase portraits	Yes	
13.	Singular points	Yes	
14.	Limit cycles	Yes	
15.	Construction of phase portraits	Yes	
16.	Phase plane analysis of linear and non-linear systems	Yes	
17.	Isocline method	Yes	
18.	Isocline method	Yes	
UNIT III	**DESCRIBING FUNCTION ANALYSIS**		
19.	Basic concepts	No	T2
20.	Basic concepts	No	
21.	derivation of describing functions for common non-linearities	Yes	
22.	derivation of describing functions for common non-linearities	Yes	
23.	Describing function analysis of non-linear systems	Yes	
24.	Describing function analysis of non-linear systems	Yes	
25.	limit cycles	Yes	
26.	Stability of oscillations	Yes	
27.	Stability of oscillations	Yes	

UNIT IV	**OPTIMAL CONTROL**		
28.	Introduction	No	T2
29.	Time varying optimal control	Yes	
30.	Time varying optimal control	Yes	
31.	LQR steady state optimal control	Yes	
32.	LQR steady state optimal control	Yes	
33.	Solution of Ricatti's equation	Yes	
34.	Solution of Ricatti's equation	Yes	
35.	Application examples	Yes	
36.	Application examples	Yes	
UNIT V	**OPTIMAL ESTIMATION**		
37.	Optimal estimation	Yes	T2
38.	KalmanBucy Filter-Solution by duality principle-Discrete systems	Yes	
39.	KalmanBucy Filter-Solution by duality principle-Discrete systems	Yes	
40.	Discrete systems	Yes	
41.	Discrete systems	Yes	
42.	Kalman Filter	Yes	
43.	Kalman Filter	Yes	
44.	Application examples	Yes	
45.	Application examples	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		5%
Cycle Test – II	-	5%
Model Test	-	10%
Attendance	-	5%
Seminar&Assignment	-	5%
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)