Academic Course Description

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

BEE052 &ELECTRICAL MACHINE MODELING AND ANALYSIS
Sixth Semester (Even Semester)

Course (catalog) description

To master the various fundamentals, machine design, machine modeling of various types of electrical machines. This will help you to gain knowledge and to do research in the area of electrical machine modeling

Compulsory/Elective course: Elective for EEE students

Credit & Contact hours : 3 and 45 hours

Course Coordinator : Mrs.Anitha Sampath kumar

Instructors : S. Dinakar Raj

Name of the instructor	Class handling	Office location	Office phone	Email (domain:@ bharathuniv.ac.in	Consultation
S. Dinakar Raj	Third year EEE	KS 302	04422290125	rajdina@gmail.com	9.00-9.50 AM

Relationship to other courses:

Pre –requisites : BEE504 (Electrical Machine Design)

Assumed knowledge : Knowledge in machine design

Syllabus Contents

UNIT I BASIC CONCEPTS OF MODELING 9

Basic Two - pole Machine representation of Commutator machines, 3 phase synchronous machine with and without damper bars and 3 - phase induction machine, Kron's primitive Machine - voltage, current and Torque equations. DC Machine modeling: Mathematical model of separately excited D.C motor –Steady State analysis - Transient State analysis - Sudden application of Inertia Load - Transfer function of Separately excited D.C Motor - Mathematical model of D.C Series motor, Shunt motor - Linearization Techniques for small perturbations

UNIT II REFERENCE FRAME THEORY 9

Reference frame theory Real time model of a two phase induction machine-Transformation to obtain constant matrices - three phase to two phase transformation - Power equivalence. Dynamic modeling of three phase Induction Machine Generalized model in arbitrary reference frame - Electromagnetic torque -

Derivation of commonly used Induction machine models - Stator reference frame model - Rotor reference frame model Synchronously rotating reference frame model -Equations in flux linkages - per unit model

UNIT III SMALL SIGNAL MODELING 9

Small Signal Modeling of Three Phase Induction Machine Small signal equations of Induction machine – derivation - DQ flux linkage model derivation - control principle of Induction machine. Symmetrical and Unsymmetrical 2 phase Induction Machine Analysis of symmetrical 2 phase induction machine - voltage and torque equations for unsymmetrical 2 phase induction machine - voltage and torque equations in stationary reference frame variables for unsymmetrical 2 phase induction machine - analysis of steady state operation of unsymmetrical 2 phase induction machine - single phase induction motor - Cross field theory of single - phase induction machine.

UNIT IV MODELING OF SYNCHRONOUS MACHINE 9

Synchronous machine inductances – voltage equations in the rotor's dq0 reference frame - electromagnetic torque - current in terms of flux linkages - simulation of three phase synchronous machine- modeling of PM Synchronous motor.

UNIT V DYNAMIC ANALYSIS OF SYNCHRONOUS MACHINE 9

Dynamic performance of synchronous machine, three -phase fault, comparison of actual and approximate transient torque characteristics, Equal area criteria

Text Books:

T1. R. Krishnan, "Electric Motor Drives - Modeling, Analysis& control", Pearson Publications, First edition, 2002.

T2. P.C.Krause, Oleg Wasynczuk, Scott D.Sudhoff, "Analysis of Electrical Machinery and Drive systems", IEEE Press, Second Edition

References:

R1.P.S.Bimbra, "Generalized Theory of Electrical Machines" Khanna publications, Fifth edition - 1995

R2. CheeMunOng –"Dynamic simulation of Electric machinery using MATLAB / Simulink", Prentice Hall of India Publications

R3. Online courses on Modeling of Electrical Machines -http://nptel.ac.in/courses/108106023/

Computer usage:

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 28	2 Periods
3	Model Test	April 3rd week	Session 1 to 45	3 Hrs
4	University Examination	TBA	All sessions / Units	3 Hrs.

Mapping of Instructional Objectives with Program Outcome

To master the various fundamentals, machine design, machine modeling of various types of electrical machines. This will help you to gain knowledge and to do research in the area of electrical machine modeling	Correlates to program outcome		
	H	**M**	**L**
1. To learn about the basic concepts of AC/ DC machine modeling.	b	c,d,e,f,g,i,j,l	h, k
2. To study about the dynamic modeling and phase transformation	b,e	d,f,g,i,j,l	h,k
3. To analyze various methodologies in small signal machine modeling	a,b	i,j	
4. To understand the modeling of synchronous machine modeling	a,f,l	c,g,j	
5. To learn the performance and dynamic modeling of synchronous machines	a,b,d,e,f	c,g,h,i,j,l	l

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

Draft Lecture Schedule

S.NO	Topics	Problem solving (Yes/No)	Text / Chapter
UNIT I	**BASIC CONCEPTS OF MODELING**		
1.	Basic Two - pole Machine representation of Commutator machines	NO	[R1],[T1]
2.	3 phase synchronous machine with and without damper bars	NO	
3.	3 - phase induction machine	YES	
4.	Kron's primitive Machine - voltage	YES	
5.	current and Torque equations	YES	
6.	DC Machine modeling	YES	
7.	Transient State analysis	YES	
8.	Sudden application of Inertia Load b	YES	
9.	Transfer function of Separately excited D.C Motor	YES	
10.	Mathematical model of D.C Series motor, Shunt motor	YES	
11.	Linearization Techniques for small perturbations	YES	
UNIT II	**REFERENCE FRAME THEORY**		
12.	Reference frame theory Real time model of a two phase induction machine	YES	[R1],[T2]
13.	Transformation to obtain constant matrices	YES	
14.	three phase to two phase transformation	YES	
15.	Power equivalence. Dynamic modeling of three phase Induction Machine Generalized model in arbitrary reference frame	YES	
16.	Electromagnetic torque	YES	
17.	Derivation of commonly used Induction machine models	YES	
18.	Stator reference frame model	YES	
19.	- Rotor reference frame model Synchronously rotating reference frame model	YES	
20.	Equations in flux linkages	YES	

21.	per unit model	YES	
UNIT III	**SMALL SIGNAL MODELING**		
22.	Small Signal Modeling of Three Phase Induction Machine Small signal equations of Induction machine	YES	[R1],[T1]
23.	derivation - DQ flux linkage model derivation - control principle of Induction machine	YES	
24.	Symmetrical and Unsymmetrical 2 phase Induction Machine Analysis of symmetrical 2 phase induction machine	YES	
25.	voltage and torque equations for unsymmetrical 2 phase induction machine	YES	
26.	voltage and torque equations in stationary reference frame variables for unsymmetrical 2 phase induction machine	YES	
27.	analysis of steady state operation of unsymmetrical 2 phase induction machine	YES	
28.	single phase induction motor	YES	
29.	Cross field theory of single	YES	
30.	phase induction machine	YES	
31.	Problem solved	YES	
UNIT IV	**MODELING OF SYNCHRONOUS MACHINE**		
32.	Synchronous machine inductances	YES	[R1],[T1],[R3]
33.	voltage equations in the rotor's dq0 reference frame	YES	
34.	electromagnetic torque	YES	
35.	current in terms of flux linkages	YES	
36.	simulation of three phase synchronous machine-modeling of PM Synchronous motor	YES	
37.	Problem solved	YES	
38.	Revision of electromagnetic torque	YES	
39.	Revision of voltage equations	YES	
40.	Revision of synchronous machine inductance	YES	
41.	Problems on voltage equations(revision)	YES	
UNIT V	**DYNAMIC ANALYSIS OF SYNCHRONOUS MACHINE**		
42.	Dynamic performance of synchronous machine	YES	[R1],[R2]
43.	three -phase fault, comparison of actual and approximate transient torque characteristics	YES	
44.	Equal area criteria, Problems on three phase fault, Revision of area criteria	YES	
45.	Revision of dynamic performance of synchronous machine	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&Assignmei	-	5%
Final exam	-	70%

Prepared by: Mrs.Anitha Sampath kumar **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
S. Dinakar Raj	

Course Coordinator **HOD/EEE**

(Mrs.Anitha Sampath kumar) ( )