INSTITUTE OF AERONAUTICAL ENGINEERING

Dundigal, Hyderabad - 500 043

ELECTRICAL AND ELECTRONICS ENGINEERING

COURSE DESCRIPTION FORM

Course Title	**POWER ELECTRONIC CONTROL OF AC DRIVES**			
Course Code	**BPE004**			
Regulation	**2017-18**			
Course Structure	Lectures	Tutorials	Practicals	Credits
	3	-	-	3
Course Coordinator	Mr.S. Srikanth, Assistant professor			
Team of Instructors	Mr.S. Srikanth, Assistant professor			

I. COURSE OVERVIEW:

1. Understand various converters used in AC drives.
2. Distinguish the speed control of induction motors with various power electronics converters.
3. Understand the speed control of synchronous motors with various power electronics converters.
4. Apply the knowledge of reluctance motor drives.

II. PREREQUISITES:

Level	Credits	periods	prerequisite
PG	**3**	**3**	**Knowledge of power electronic converters and ac machines are required**

III. COURSE ASSESSMENT METHODS:

Marks distribution:

Session marks	University end exam marks	Total marks
There shall be two continuous internal assessments (CIA). Each continuous internal assessment is for 30 marks, with subjective exam for 25 marks (duration of 2 hours) and 5 marks for technical paper and term paper. Subjective test of each CIA in the semester shall contain Part-A with 5 compulsory question to answer of one mark each and Part-B with 5 questions each carrying 5 marks and to be answer any four questions.	30	100

The average of two CIA is the final internal marks. The external question paper approved by COE contains 5 internal choice questions each carrying 14 marks giving an total of 70 marks and to be answer all 5 questions	70	

IV. EVALUATION SCHEME:

S.No	Component	Duration	Marks
1	I CIA examination	2 Hours	25
2	I technical paper and term paper	--	05
3	II CIA examination	2 Hours	25
4	II technical paper and term paper	--	05
5	External examination	3 hours	70

V. COURSE OBJECTIVES:

At the end of the course, the students will be able to:

I. Understand various converters used in induction motor drives.
II. Distinguish the speed control of induction motors with v/f control using various power electronics converters.
III. Analyze the speed control of induction motors with rotor resistance control.
IV. Understand the speed control of synchronous motors with various power electronics converters.
V. Apply the knowledge of reluctance motor drives.

VI. COURSE OUTCOMES:

After completing this course the student must demonstrate the knowledge and ability to:

1. Understands the operation and characteristics of induction motor in different modes.
2. Apply the knowledge of power electronic converters in the speed control of induction motor with stator side parameters.
3. Analyze the speed control of induction motors with rotor side parameters.
4. Describe the power electronic converters used for the speed control of synchronous motors.
5. Evaluate the operation of reluctance motor drives.

VII. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program outcomes		Level	Proficiency assessed by
PO1	**General Knowledge**: An ability to apply the knowledge of mathematics, science and Engineering for solving multifaceted issues of Electrical Engineering.	S	Discussion
PO2	**Problem Analysis**: An ability to communicate effectively and to prepare formal technical plans leading to solutions and detailed reports for electrical systems.	S	Assignments
PO3	**Design / Development of Solutions**: To develop Broad theoretical knowledge in Electrical Engineering and learn the methods of applying them to identify, formulate and solve practical problems involving electrical power.	N	--
PO4	**Conduct Investigations of Complex Problems**: An ability to apply the techniques of using appropriate technologies to investigate, analyze, design, simulate and/or fabricate/commission complete systems involving generation, transmission and distribution of electrical energy	H	Discussion
PO5	**Modern tool usage:** An ability to model real life problems using different hardware and software platforms, both offline and real-time with the help of various tools along with upgraded versions.	H	Discussion ,Assignment
PO6	**The Engineer and Society:** An Ability to design and fabricate modules, control systems and relevant processes to meet desired performance needs, within realistic constraints for social needs.	N	--
PO7	**Environment and Sustainability:** An ability To estimate the feasibility, applicability, optimality and future scope of power networks and apparatus for design of eco-friendly with sustainability	N	--
PO8	**Ethics:** To Possess an appreciation of professional, societal, environmental and ethical issues and proper use of renewable resources.	N	--
PO9	**Individual and Team Work:** an Ability to design schemes involving signal sensing and processing leading to decision making for real time electrical engineering systems and processes at individual and team levels	S	Discussion ,Assignment
PO10	**Communication:** an Ability to work in a team and comprehend his/her scope of work, deliverables , issues and be able to communicate both in verbal ,written for effective technical presentation.	N	--
PO11	**Life-long Learning:** An ability to align with and upgrade to higher learning and research activities along with engaging in life-long learning.	H	Discussion ,Seminar
PO12	**Project Management and Finance**: To be familiar with project management problems and basic financial principles for a multi-disciplinary work.	H	Discussion ,Seminar

N= None S=Supportive H=Highly related

VIII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes		Level	Proficiency assessed by
PSO1	**Professional Skills:** Able to utilize the knowledge of high voltage engineering in collaboration with power systems in innovative, dynamic and challenging environment, for the research based team work.	N	--
PSO2	**Problem-Solving Skills:** Can explore the scientific theories, ideas, methodologies and the new cutting edge technologies in renewable energy engineering and use this erudition in their professional development and gain sufficient competence to solve the current and future energy problems universally.	S	Projects
PSO3	**Successful Career and Entrepreneurship:** The understanding of technologies like PLC, PMC, process controllers, transducers and HMI one can analyze, design electrical and electronics principles to install, test , maintain power system and applications.	S	Projects

N – None **S - Supportive** **H- Highly Related**

IX. SYLLABUS:

UNIT I : INDUCTION MOTOR DRIVES

Introduction to induction motor drives: Torque production, equivalent circuit analysis, speed, torque characteristics with variable voltage operation variable frequency operation constant v/f operation, variable stator current operation, induction motor characteristics in constant torque and field weakening regions.

UNIT II: STATOR SIDE CONTROL OF INDUCTION MOTOR DRIVES

Scalar control: Voltage fed inverter control , open loop volts / Hz control, speed control slip regulation, speed control with torque and flux control, current controlled voltage fed inverter drive, current fed inverter control, independent current and frequency control, speed and flux control in current fed inverter drive, volts / Hz control of current fed inverter drive, efficiency, optimization control.

UNITIII: ROTOR SIDE CONTROL OF INDUCTION MOTOR DRIVES

Slip power recovery drives: Static Kramer Drive, phasor diagram and torque expression, speed control of Kramer drive, static Scheribus drive modes of operation.

Vector control of induction motor drives: Principles of vector control, vector control methods, direct methods of vector control, indirect methods of vector control, adaptive control principles, self tuning regulator model referencing control.

UNIT IV: CONTROL OF SYNCHRONOUS MOTOR DRIVES

Synchronous motor and its characteristics: Control strategies, constant torque angle control, unity power factor control, constant mutual flux linkage control. Controllers, flux weakening operation, maximum speed, direct flux weakening algorithm, constant torque mode controller, flux weakening controller, indirect flux weakening, maximum permissible torque, speed control scheme, implementation strategy speed controller design.

UNIT V: VARIABLE RELUCTANCE MOTOR DRIVE

Variable Reluctance motor drive: Torque production in the variable reluctance motor drive characteristics and control principles, current control of variable reluctance motor drive, brushless DC motor drives, three phase full wave brushless DC motor drive, sinusoidal type of brushless DC motor, current controlled brushless DC motor servo drive, applications and numerical problems.

TEXT BOOKS:

1. M H Rashid, "Power Electronic circuits Devices and Applications", PHI, 1st Edition 1995.
2. G. K. Dubey, "Fundamentals of Electrical Drives", Narora publications, 1st Edition 1995.
3. BK Bose, "Power Electronics and Variable frequency drives", IEEE Press, Standard publications, 1st Edition 2002.
4. Bimal Bose, "Power Electronics and Motor Drives Advances and Trends", Elesevier 1st Edition

REFERENCES:

1. R. Krishnan, "Electric Motor Drives Pearson Modeling, Analysis and control", PHI Publications, 1st Edition, 2002.
2. B K Bose, "Modern Power Electronics and AC Drives", Pearson Publications, 1st Edition, 2005.
3. MD Murthy, FG Turn Bull, " Power Electronics and Control of AC Motors", Pergman Press, 1st Edition.
4. BK Bose, "Power Electronics and AC Drives", Prentice Hall Eagle wood 1st Edition.

X. COURSE PLAN:

The course plan is meant as a guideline. There may be probably be changes.

Lecture no.	Topics to be covered	Course Learning objectives	Reference
1	Gets the knowledge of induction motor drives	Introduction to induction motor drives	T1T2
2	Can understand operation of induction motor and torque production	operation of induction motor and torque production	T1T2
3	Can understand the Equivalent circuit analysis of induction motor	Equivalent circuit analysis of induction motor	T1T2
4	Can understand the Speed torque characteristics of three phase induction motor	Speed torque characteristics of three phase induction motor	T1T2
5	Can understand the Speed torque characteristics of three phase induction motor with variable voltage operation	Speed torque characteristics of three phase induction motor with variable voltage operation	T1T2
6	One can understand the Speed torque characteristics of three phase induction motor with variable frequency operation	Speed torque characteristics of three phase induction motor with variable frequency operation	T1T2
7	Gets the knowledge of Voltage / frequency control in induction motors	Voltage / frequency control in induction motors	T1T2
8	Can understand the Variable stator current	Variable stator current operation in	T1T2

	operation in induction motors	induction motors	
9	Can understand the Induction motor characteristics in constant torque and field weakening regions	Induction motor characteristics in constant torque and field weakening regions	T1T2
10	Can understand the Scalar control of induction motor voltage fed inverter control	Scalar control of induction motor voltage fed inverter control	T1T2
11	Can understand the Open loop volts/Hz control of induction motor	Open loop volts/Hz control of induction motor	T1T2
12	Can understand Speed control with slip regulation, speed control with torque and flux control	Speed control with slip regulation, speed control with torque and flux control	T1T2
13	Can understand the operation of Current controlled voltage fed inverter drive	Operation of Current controlled voltage fed inverter drive	T1T2
14	Can understand the Operation of induction motor with independent current and frequency control	Operation of induction motor with independent current and frequency control	T1T2
15	Can understand the operation of Speed and flux control in current fed inverter drive	Speed and flux control in current fed inverter drive	T1T2
16	Able to operate drive with v/f control in current fed inverter	v/f control of current fed inverter drive	T1T2
17	Able to know the Efficiency and optimization control of induction motor drive	Efficiency and optimization control of induction motor drive	T1T2
18	Able to know the operation Slip power recovery drives	Introduction to Slip power recovery drives	T1T2
19	Able to know the operation of static krammer drive phasor diagram and torque expression	Operation of static krammer drive phasor diagram and torque expression	T1T2
20	Can understand the Speed control of krammer drive	Speed control of krammer drive	T1T2
21	Can understand the modes of operation of static scherbius drive	Different modes of static scherbius drive	T1T2
22	Can understand the vector control of induction motor drives	Introduction to vector control of induction motor drives	T1T2
23	Can study the Principle of vector control and vector control methods	Principle of vector control and vector control methods	T1T2
24	Can understand Direct methods of vector control	Direct methods of vector control	T1T2
25	Can understand indirect methods of vector control	indirect methods of vector control	T1T2
26	Can understand Adaptive control principles in induction motor drive	Adaptive control principles in induction motor drive	T1T2
27	Can understand Self tuning regulator model referencing control	Self tuning regulator model referencing control	T1T2
28, 29	Can understand Control strategies and constant torque angle control in synchronous motor drives	Control strategies and constant torque angle control in synchronous motor drives	T1T2
30	Can understand Unity power factor control and constant mutual flux linkage control	Unity power factor control and constant mutual flux linkage control	T1T2
31	Can understand Issues of capacitor voltage balancing	Controllers and flux weakening operation	T1T2
32	Can understand the Maximum speed of	Maximum speed of synchronous motor	T1T2

	synchronous motor and direct flux weakening algorithm	and direct flux weakening algorithm	
33	Can understand Operation of Constant torque mode controller and flux weakening control	Operation of Constant torque mode controller and flux weakening control	T1T2
34	Can understand Indirect flux weakening in synchronous motor drives	Indirect flux weakening in synchronous motor drives	T1T2
35	can understand Maximum permissible torque and speed control schemes	Maximum permissible torque and speed control schemes	T1T2
36	Can understand Implementation strategy in speed controller design	Implementation strategy in speed controller design	T1T2
37	Can understand Torque production in the variable reluctance motor drive characteristics	Torque production in the variable reluctance motor drive characteristics	T1T2
38	Can understand Control principles in variable reluctance motor drive	Control principles in variable reluctance motor drive	T1T2
39	Can understand Current control of variable reluctance motor drive	Current control of variable reluctance motor drive	T1T2
40	Can understand the operation of Brushless dc motor drives	Introduction to Brushless dc motor drives	T1T2
41	Can understand the operation of Three phase full wave brushless dc motor drive	The operation of Three phase full wave brushless dc motor drive	T1T2
42	Can understand Operation of Sinusoidal type of brushless dc motor	Operation of Sinusoidal type of brushless dc motor	T1T2
43	Can understand Current controlled brushless dc motor servo drive	Current controlled brushless dc motor servo drive	T1T2
44	Able to know the applications and numerical problems	applications and numerical problems	T1T2

XI. MAPPING COURSE OBJECTIVES LEADING TO THE ACHIEVEMENT OF THE PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Objectives	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
I	S		H		S	S			S		H				S
II		S	H	S		H					S	H		H	S
III	S			H		S			S		H	H			S
IV	S		H		S	H			S		H	H		S	
V		S		H	H	S					H	S		H	

S=Supportive H=Highly related

XII. MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF THE PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	S		H		S	S			S		H				S
2		S	H	S		H					S	H		H	S
3	S			H		S			S		H	H			S
4	S		H		S	H			S		H	H		H	
5		S		H	H	S					H	S		S	

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Prepared by: Mr.S. Srikanth Assistant professor