INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

ELECTRICAL AND ELECTRONICS ENGINEERING

COURSE DESCRIPTION FORM

Course Title	**STATIC DRIVES**			
Course Code	**A60225**			
Regulation	**R15 – JNTUH**			
Course Structure	**Lectures**	**Tutorials**	**Practicals**	**Credits**
	4	**-**	**-**	**4**
Course Coordinator	**Mr. P Shiva Kumar, Assistant Professor**			
Team of Instructors	**Mr. P Shiva Kumar, Assistant Professor**			

I. COURSE OVERVIEW:

This course is an extension of power electronics applications to AC and Dc drives. Control of DC Motor drives with single phase and three phase converters and choppers are given in detail. The control of AC motor drives with variable frequency converters and variable voltage are presented.

II. PREREQUISITES:

Level	Credits	Periods / Week	Prerequisite
UG	4	4	Knowledge of power electronic converters, DC and AC Motors are required

III. COURSE ASSESSMENT METHODS:

a) Marks distribution:

Session Marks	University End Exam Marks	Total Marks
There shall be two mid tem examinations. Each id term exam consists of subjective type and objective type test. The subjective test is for 10 marks, with duration of 1 hour. Subjective test of each semester shall contain four questions; the student has to answer two out of them. Each carrying 5 marks The objective test paper Is prepared by JNTUH, which consists of 20 questions each carrying 0.5 marks and total of 10 marks. The student is assessed by giving two assignments, one, after completion of 1 to 2 1/2 units and the second, after the completion of 2 1/2 to 5 units each carrying 5 marks. On the total the internal marks are 25.	75	100

The average of two internal tests is the final internal marks. The external question paper is set by JNTUH consisting of part A and part-B. Where part consists of short answer questions carrying total marks of 25 and part part-B consists of 5 essay type questions consists of internal choice each carrying 10 marks and the total of 50. The total external marks are 75.		

IV. EVALUATION SCHEME:

S. No	Component	Duration	Marks
1	I Mid Examination	80 minutes	20
2	I Assignment	--	05
3	II Mid Examination	80 minutes	20
4	II Assignment	--	05
5	External Examination	3 hours	75

V. COURSE OBJECTIVES

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

I. Understand the basic fundamentals of the speed control of DC motor with single phase and three phase controlled rectifiers.
II. Analyze and understand the four quadrant operation of DC Drives through Dual converters.
III. Understand the speed control DC Motors by Choppers.
IV. Acquire the knowledge and be familiar with the speed control of Induction Motors with variable voltage and variable frequency operation.
V. Understand the speed control of synchronous motors.

VI. COURSE OUTCOMES:

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

1. Understand the speed control of DC motor with single phase controlled rectifiers.
2. Understand the speed control of DC motor with three phase controlled rectifiers.
3. Analyze the speed torque characteristics of DC motors for various firing angles.
4. Analyze the four quadrant operation of DC drives.
5. Understand the braking methods of DC drives.
6. Apply the knowledge of dual converters for four quadrant operation of DC motors.
7. Understand the control techniques for the operation of choppers.
8. Apply the knowledge of Choppers for speed control of DC Motors.
9. Analyze the four quadrant operation of DC motors with choppers.
10. Understand the speed control of induction motors with variable voltage control.
11. Understand the speed control of induction motors with variable frequency control.
12. Analyze the speed control of induction motor with rotor resistance control.
13. Apply the knowledge of cyclo converters for speed control of synchronous Motors.
14. Analyze the speed control of synchronous Motors with VSI.
15. Apply the knowledge of CSI for speed control of synchronous Motors.
16. Apply the knowledge of DC, AC motors and power electronics.
17. Process the knowledge and skills for employability and to succeed national and international level competitive examinations.

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.	H	Assignments
PO2	**Problem Analysis**: An ability to communicate effectively and to prepare formal technical plans leading to solutions and detailed reports for electrical systems.	S	Exercises
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.	H	Assignments
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	S	Prototypes
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.	S	Prototypes
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	N	-
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:** ability to align with and upgrade to higher learning and research activities along with engaging in life-long learning.	S	Workshops, Prototypes
PO12	**Project Management and Finance**: To be familiar with project management problems and basic financial principles for a multi-disciplinary work.	H	Seminar, Discussions

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.	H	Lectures, Assignments
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.	N	--
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:

Control of DC motors through phase controlled Rectifiers

Introduction to Thyristor controlled Drives, Single Phase semi and fully controlled converters connected to DC separately excited and DC series motors – continuous current operation – output voltage and current waveforms – Speed and Torque expressions – Speed – Torque Characteristics- Problems on Converter fed DC motors. Three phase semi and fully controlled converters connected to DC separately excited and DC series motors – output voltage and current waveforms – Speed and Torque expressions – Speed – Torque characteristics – Problems.

UNIT - II:

Four Quadrant operations of DC Drives

Introduction to Four quadrant operation – Motoring operations, Electric Braking – Plugging, Dynamic and Regenerative Braking operations. Four quadrant operation of DC motors by dual converters – Closed loop operation of DC motor (Block Diagram Only)

UNIT - III:

Control of DC motors by Choppers

Single quadrant, Two –quadrant and four quadrant chopper fed DC separately excited and series excited motors – Continuous current operation – Output voltage and current wave forms – Speed torque expressions – speed torque characteristics – Problems on Chopper fed DC Motors – Closed Loop operation (Block Diagram Only)

UNIT - IV:

Control of Induction Motors: Variable voltage Characteristics

Control of Induction Motor by Ac Voltage Controllers – Waveforms – speed torque characteristics.

Variable Frequency Characteristics

Variable frequency characteristics-Variable frequency control of induction motor by Voltage source and current source inverter and cyclo converters- PWM control – Comparison of VSI and CSI operations – Speed torque characteristics – numerical problems on induction motor drives – Closed loop operation of induction motor drives (Block Diagram Only)

Static rotor Resistance control

Slip power recovery – Static Scherbius drive – Static Kramer Drive – their performance and speed torque characteristics – advantages applications – problems

UNIT - V:

Control of Synchronous Motors

Separate control & self control of synchronous motors – Operation of self controlled synchronous motors by VSI and CSI cyclo converters. Load commutated CSI fed Synchronous Motor – Operation – Waveforms – speed torque characteristics – Applications – Advantages and Numerical Problems – Closed Loop control operation of synchronous motor drives (Block Diagram Only), variable frequency control, Cyclo converter, PWM, VFI, CSI

TEXT BOOKS:

1. Power semiconductor drives, PV Rao
2. Fundamentals of Electric Drives – by G K Dubey Narosa Publications

REFERENCE BOOKS:

1. Power semiconductor drives, SB Devan, GR Slemon, A. Straughen, Wiley Pvt ltd.
2. Electric Drives NK De, PK Sen, PHI learning private Ltd.
3. Thyristor Control of Electric drives – Vedam Subramanyam Tata McGraw Hill Publilcations.
4. Electrical machines and drive systems, John Hindmarsh, Alasdair Renfew, Newnes.
5. Electrical motors and drives Fundamentals, Types and applications Austin Hughes, Newnes.
6. Power electronics and variable frequency drives technology and applications, Bimal.K.Bose, wiley India Pvt.Ltd.
7. A First course on Electrical Drives – S K Pillai New Age International (P) Ltd. 2nd Editon.
8. Modern Power Electronics and AC Drives by B.K.Bose, PHI.
9. Power electronic circuits, devices and applications, MH Rashid, PHI.

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	Introduction to thyristor control drives	To know what is the importance of thyristor control drive	T2 1.1
2	Single phase semi controlled fed DC separately excited motor	To know the operation of semi controlled fed DC drive	T2 5.1.1
3	Single phase semi controlled fed DC series motor	To know the operation of semi controlled fed DC series drive	T2 5.1.2
4	Single phase full controlled fed DC separately excited motor	To know the operation of full controlled fed DC drive	T2 5.1.1
5	Single phase full controlled fed DC series motor	To know the operation of full controlled fed DC series drive	T2 5.1.2
6	Problems on DC drives fed through single phase semi and fully controlled converters	Exercise problems	T2 5.1.1, 5.1.2
7	Three phase semi controlled fed DC separately excited motor	To know the operation of semi controlled fed DC drive	T2 5.12

8	Three phase semi controlled fed DC series motor	To know the operation of semi controlled fed DC series drive	T2 5.13
9	Three phase full controlled fed DC separately excited motor	To know the operation of full controlled fed DC drive	T2 5.12
10	Three phase full controlled fed DC series motor	To know the operation of full controlled fed DC series drive	T2 5.13
11,12	Solving problems on DC drives fed through three phase semi and fully controlled converters	Exercise problems	T2 5.12, 5.13
13	Introduction to four quadrant operation of DC drives	To introduce four quadrant operation of DC drives	T2 5.14
14	Motoring operations	To know the operation of DC drive in motoring mode	T2 5.2
15	Braking operations – plugging	To know the operation of DC drive in braking mode	T2 5.3.3
16	Solving problems	Exercise problems	T2 5.3.3
17,18	Dynamic braking and regenerative braking	To know the operation of DC drive in braking mode	T2 5.3.1, 5.3.2
19	Solving problems	Exercise problems	T2 5.3.1, 5.3.2
20,21	Four quadrant operation of DC motors by dual converters	To know the four quadrant operation of DC motor	T2 5.14.2
22	Closed loop operation of DC motor	To control the speed of DC motor with closed loop operation	T2 5.22
23	Solving problems	Exercise problems	T2 5.14
24	Introduction to speed control of DC motors by choppers	To know the speed control operation of DC motors by choppers	T2 5.18
25,26	Single quadrant chopper fed DC separately excited and series motors	To know the operation of DC drive fed through single quadrant chopper	T2 5.19
27	Two quadrant chopper fed DC separately excited and series motors	To know the operation of DC drive fed through two quadrant chopper	T2 5.19, 5.20
28	Solving problems	Exercise problems	T2 5.20
29,30	Four quadrant chopper fed DC separately excited and series motors	To know the operation of DC drive fed through four quadrant chopper	T2 5.21
31, 32	Continuous current operation and waveforms	To plot the output voltage and current waveforms	T2 5.21
33	Speed torque expressions and characteristics	To draw the speed torque characteristics	T2. 5.20
34	Solving problems	Exercise problems	T2 5.19
35	Closed loop operation of DC motor using choppers	To analyze the operation of DC drive fed through chopper with closed loop	T2 5.22
36	Solving problems	Exercise	T2 5.22
37,38	Speed control of induction motor by AC voltage controllers with waveforms	To draw the waveforms of AC voltage controller fed induction motor	T2 6.11

39	Solving problems	Exercise problems	T2 6.12
40	Variable frequency control of induction motor by VSI	To control the induction motor with variable frequency using VSI	T2 6.13
41	Variable frequency control of induction motor by CSI	To control the induction motor with variable frequency using CSI	T2 6.16
42	Solving problems	Exercise problems	T2 6.16
43	Variable frequency control of induction motor by Cyclo converter	To control the induction motor with variable frequency using Cyclo converter	T2 6.14
44	Comparison of VSI and CSI operations	To compare the VSI and CSI operations	T2 6.17.3
45	Closed loop operation of induction motor drives	To know the closed loop operation of induction motor drives	T2 6.19
46	Slip power recovery schemes – static scherbius drive	To know the operation of static scherbius drive	T2 6.21
47	Static Kramer drive and advantages of slip power recovery schemes	To know the operation of static Kramer drive	T2 6.21.1
48	Solving problems	Exercise	T2 6.21.2
49, 50	Speed control of synchronous motor with separate control with VSI and CSI cyclo converters	To control the speed of synchronous motor with separate control	T2 7.3
51, 52	Speed control of synchronous motor with self control with VSI and CSI cyclo converters	To control the speed of synchronous motor with self control	T2 7.4
53	Problem solving	Exercise problems	T2 7.4
54, 55	Load commutated CSI fed synchronous motor with waveforms and speed torque characteristics	To know operation of CSI fed synchronous motor with load commutated	T2 7.5
56	Applications, advantages of speed control of synchronous motors	To know the Applications, advantages of speed control of synchronous motors	T2 7.7
57	Problem solving	Exercise problems	T2 7.7
58	Closed loop control of synchronous motor drives	To know the closed loop operation of synchronous motor drives	T2 7.8
59	Variable frequency control of synchronous motor with cyclo converter	To know the synchronous motor operation with variable frequency control	T2 7.7
60	Variable frequency control of synchronous motor with PWM, VFI and CSI	To know the synchronous motor operation with variable frequency control	T2 7.10

XI. MAPPING COURSE OBJECTIVES LEADING TO THE ACHIEVEMENT OF THE PROGRAM 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	S	S	-	S	-	-	-	-	-	-	S	H	-	S
II	H	-	S	S	-	-	-	-	-	-	-	S	S	-	S
III	-	S	-	S	S	-	-	-	-	-	-	S	H	-	-
IV	H	-	S	-	-	-	-	-	-	-	S	S	-	-	S
V	S	S	-	H	S	-	-	-	-	-	S	S	H	-	S

S – Supportive

XII. MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF THE PROGRAM 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	S	S	-	S	-	-	-	-	-	-	S	H	-	S
2	S	H	S	-	S	-	-	-	-	-	-	H	S	-	S
3	H	S	S	-	S	-	-	-	-	-	-	S	H	-	S
4	H	-	-	S	-	-	-	-	-	-	-	-	S	-	S
5	S	S	S	S	-	-	-	-	-	-	-	S	-	-	S
6	H	-	S	S	-	-	-	-	-	-	-	S	S	-	H
7	S	S	-	S	S	-	-	-	-	-	-	S	H	-	-
8	-	H	-	S	S	-	-	-	-	-	-	S	H	-	S
9	S	S	-	S	S	-	-	-	-	-	-	S	H	-	S
10	H	-	S	-	-	-	-	-	-	-	S	S	H	-	S
11	H	-	S	-	S	-	-	-	-	-		S	-	-	S
12	H	-	S	S	-	-	-	-	-	-	S	S	S	-	S
13	S	S	-	H	S	-	-	-	-	-	S	-	H	-	S
14	S	-	S	-	S	-	-	-	-	-	S	-	S	-	H
15	S	S	-	H	S	-	-	-	-	-	S	S	H	-	S
16	H	S	S	H	S	-	-	-	-	-	-	-	H	-	S
17	H	S	S	H	S	-	-	-	-	-	-	-	H	-	-

S – Supportive

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