POWER SEMICONDUCTOR DRIVES

Subject Code : EE612PE
Regulations : R18 - JNTUH
Class : III Year B.Tech EEE II Semester

Department of Electrical and Electronics and Engineering

BHARAT INSTITUTE OF ENGINEERING AND TECHNOLOGY

Ibrahimpatnam - 501 510, Hyderabad

POWER SEMICONDUCTOR DRIVES
COURSE PLANNER

Course Title	Power Semiconductor Drives (PSD)			
Course Code	PE-II			
Class	B.Tech. III Year II Semester EEE			
Regulations	JNTUH - R18			
Course Structure	Lectures	Tutorials /Bridge	Practicals	Credits
	3	0	0	3
Course Coordinator	Mr P Sravan kumar			
Team of Instructors	Mr P Sravan kumar Assistant Professor			

I. COURSE OVERVIEW:

Power Semiconductor Drives is a course that deals with single phase and three phase converter based DC motor control, Chopper based control of DC motors, DC Drives four quadrant operation, Induction motor various control methods with respect to stator voltage, stator frequency and rotor side control, synchronous motor control methods. This course subject is an extension of power electronics applications to AC and DC drives give knowledge about power semiconductor drives and motor control.

This course provides

- An understanding of power semiconductor drives operations, modes, characteristics.
- An understanding How to control machines using power semiconductor drives.
- An understanding to differentiate the classical and newly developed control methods.
- An understanding motoring and braking operation.
- An idea to design a motor control system.
- An knowledge to choose an appropriate control method for various applications.

II. PREREQUISITE(S):

Level	**Credits**	**Periods/ Week**	**Prerequisites**
UG	3	4	1. Power Electronics 2. Electrical Machines. 3. Basic of Engineering Mathematics 4. Fundamental of Electrical Circuits.

III. COURSE OBJECTIVES:

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

- Understand the drive system and operating modes of drive and its characteristics
- Understand the Speed – Torque characteristics of different motor drives by various power converter topologies
- Understand the appreciate the motoring and braking operations of drive
- Understand the differentiate DC and AC drives

IV. COURSE OUTCOMES:

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

S. No.	Course Outcomes (CO)	Knowledge Level (Blooms Level)
CO1	Identify the drawbacks of speed control of motor by conventional methods.	**L2: UNDERSTAND**
CO2	Differentiate Phase controlled and chopper-controlled DC drives speed-torque characteristics merits and demerits	**L4: ANALYZE**
CO3	Understand Ac motor drive speed–torque characteristics using different control strategies its merits and demerits	**L3: APPLY**
CO4	Describe Slip power recovery schemes.	**L3: APPLY**
CO5	Control of synchronous motor drives	**L5: EVALUATE**

V. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes (POs)		Level	Proficiency Assessed by
PO1	**Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	Assignments / Test
PO2	**Problem Analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	2.4	Assignments /Test
PO3	**Design/Development Analysis:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.	2	Open ended experiments /Project
PO4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	2	Open ended experiments /Project
PO5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.	1.67	Mini & Major Project

PO6	**The Engineer and Society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.	1	Mini & Major Project
PO7	**Environment and Sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.	1	Mini & Major Project
PO8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	1.5	Mini & Major Project
PO9	**Individual and Team Work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	1	Mini & Major Project
PO10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.	1	Seminars / Term Paper
PO11	**Project Management and Finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.	-	--
PO12	**Life-long Learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.	1.5	Competitive Examinations/ Research

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) - : None

VI. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes (PSOs)		Level	Proficiency assessed by
PSO1	Talented to analyze, design, and implement electrical & electronics systems and deal with the rapid pace of industrial innovations and developments.	2.4	Lectures, Assignments, Mini Projects/ Experiments.
PSO2	Skillful to use application and control techniques for research and advanced studies in Electrical & Electronics Engineering domain.	2	Participate events, seminars & symposiums Mini Projects / Experiments

1: Slight (Lo1: Slight(low) 2: Moderate (Medium) 3: Substantial (High)
- : None

VII. SYLLABUS:

UNIT - I

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

UNIT - II

Four Quadrant Operation of DC Drives Introduction to Four quadrant operation – Motoring operations, Electric Braking – Plugging, Dynamic, and Regenerative Braking operations. Four quadrant operation of D.C motors by single phase and three phase dual converters – Closed loop operation of DC motor (Block Diagram Only) Control of DC Motors By Choppers: Single quadrant, Two quadrant and four quadrant chopper fed dc separately excited and series motors – Continuous current operation – Output voltage and current wave forms – Speed and torque expressions – speed-torque characteristics – Problems on Chopper fed D.C Motors – Closed Loop operation (Block Diagram Only)

UNIT - III

Control of Induction Motor Variable voltage characteristics-Control of Induction Motor by Ac Voltage Controllers – Waveforms – speed torque 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)

UNIT - IV

Rotor Side Control of Induction Motor

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 and self-control of synchronous motors – Operation of self-controlled synchronous motors by VSI, CSI and 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 based VSI & CSI.

TEXT BOOKS:

1. “G K Dubey”, Fundamentals of Electric Drives, CRC Press, 2002.
2. “Vedam Subramanyam”, Thyristor Control of Electric drives, Tata McGraw Hill Publications, 1987.

REFERENCE BOOKS:

1. “S K Pillai”, A First course on Electrical Drives, New Age International (P) Ltd. 2nd Edition. 1989
2. “P. C. Sen”, Thyristor DC Drives, Wiley-Blackwell, 1981
3. “B. K. Bose”, Modern Power Electronics, and AC Drives, Pearson 2015.
4. “R. Krishnan”, Electric motor drives - modeling, Analysis and control, Prentice Hall PTR, 2001

NPTEL Web Course:

http://www.nptelvideos.in/2012/11/advanced-electric-drives.html

NPTEL Video Course:

https://nptel.ac.in/courses/108108077/

ESE Syllabus

Semiconductor power diodes, transistors, thyristors, triacs, GTOs, MOSFETs and IGBTs - static characteristics and principles of operation, triggering circuits, phase control rectifiers, bridge converters - fully controlled and half controlled, principles of choppers and inverters, basis concepts of adjustable speed dc and ac drives, DC-DC switched mode converters, DC-AC switched mode converters, resonant converters, high frequency inductors and transformers, power supplies.

VIII. COURSE PLAN:

S.No	Date	Week	Topics to be covered	Link for PPT	Link for PDF	Link for Small Projects/ Numericals(if any)	Course Learning Outcomes	COMapping	Teaching Methodology	References
	UNIT-I: Contro of DC motors									
1		1	**UNIT1: Control of DC motors by single phase and three phase converters:** Introduction to Thyristor controlled Drives	https://docs.google.com/presentation/d/1klrA0LHAixbWo1fWuBJDkT3CfY7RR0KO/edit?usp=drive_web&ouid=115140681446534846775&rtpof=true	**https://docs.google.com/document/d/1Er_uHsmbmR89dTSqP07Ft6KQ2_x1N8sNfe4L1gzQ-V8/edit**	https://drive.google.com/drive/folders/1Pa5f07ccuxnv51M4aN2TkscTfqW5uUlr	Understand	CO1	PPT	T1&R1
2			Single Phase semi and Fully controlled converters connected to D.C separately excited and D.C series motors	**https://docs.google.com/presentation/d/1lw3jbAow-MrO08ExtfQIqMfeHARS9kj9/edit?usp=drive_web&ouid=115140681446534846775&rtpof=true**	**https://docs.google.com/document/d/1Er_uHsmbmR89dTSqP07Ft6KQ2_x1N8sNfe4L1gzQ-V8/edit**				PPT	T1&R1
3			Continuous current operation,Output voltage and current waveforms	**https://docs.google.com/presentation/d/1lw3jbAow-MrO08ExtfQIqMfeHARS9kj9/edit?usp=drive_web&ouid=115140681446534846775&rtpof=true**	**https://docs.google.com/document/d/1Er_uHsmbmR89dTSqP07Ft6KQ2_x1N8sNfe4L1gzQ-V8/edit**		Understand		PPT	T1&R1

4		2	Speed and Torque expressions,Speed – Torque Characteristics	**https://docs.google.com/presentation/d/1lw3jbAow-MrO08ExtfQIqMfeHARS9kj9/edit?usp=drive_web&ouid=115140681446534846775&rtpof=true**	**https://docs.google.com/document/d/1Er_uHsmbmR89dTSqP07Ft6KQ2_x1N8sNfe4L1gzQ-V8/edit**		Understand		PPT	T1&R1
5			Problems on Converter fed D.C motors	**https://drive.google.com/drive/folders/1mr4ecmnkKHIiFQSmtwCaN_AxGcte1tUR**	**https://drive.google.com/drive/folders/1pG7bPDln3E5EEPFL-3Xl5ff0EQoL_Dl3**		Understand		PPT	T1&R1
6			Three phase semi and fully controlled converters connected to D.C separately excited motor	**https://docs.google.com/presentation/d/1we_WrDMhM3EU6IOzX2khxplNSJzIyKGw/edit?usp=drive_web&ouid=115140681446534846775&rtpof=true**	https://docs.google.com/document/d/1Er_uHsmbmR89dTSqP07Ft6KQ2_x1N8sNfe4L1gzQ-V8/edit		Understand		PPT	T1&R1
7		3	Three phase semi and fully controlled converters connected to D.C series motors	**https://docs.google.com/presentation/d/1we_WrDMhM3EU6IOzX2khxplNSJzIyKGw/edit?usp=drive_web&ouid=115140681446534846775&rtpof=true**	**https://docs.google.com/document/d/1Er_uHsmbmR89dTSqP07Ft6KQ2_x1N8sNfe4L1gzQ-V8/edit**		Understand		PPT	T1&R1
8			Output voltage and current waveforms	**https://docs.google.com/presentation/d/1we_WrDMhM3EU6IOzX2khxplNSJzIyKGw/edit?usp=drive_web&ouid=115140681446534846775&rtpof=true**	**https://docs.google.com/document/d/1Er_uHsmbmR89dTSqP07Ft6KQ2_x1N8sNfe4L1gzQ-V8/edit**		Understand		PPT	T1&R1
9			Speed and Torque expressions,Speed – Torque Characteristics,Problems	**https://docs.google.com/presentation/d/1we_WrDMhM3EU6IOzX2khxplNSJzIyKGw/edit?usp=drive_web&ouid=115140681446534846775&rtpof=true**	**https://docs.google.com/document/d/1Er_uHsmbmR89dTSqP07Ft6KQ2_x1N8sNfe4L1gzQ-V8/edit**		Understand		PPT	T1&R1
10			**Presentaion Hour**				Understand		PPT	T1&R1
11		4	**Mock Test- I**				Understand		PPT	T1&R1

12			**UNIT 2: Four quadrant operation of DC drives:** Introduction to Four quadrant operation	**https://docs.google.com/presentation/d/1X5FIOyCvS502daZkkOvqCr3c1G26bNPK/edit?usp=drive_web&ouid=115140681446534846775&rtpof=true**	**https://drive.google.com/drive/folders/1B-TzQsWk9GKopE51AsOmAe6qLN8CuyOe**	https://drive.google.com/drive/folders/1Pa5f07ccuxnv51M4aN2TkscTfqW5uUlr	Understand	CO2	PPT	T1&R1
13			Motoring operations,Plugging, Dynamic Braking operations	**https://docs.google.com/presentation/d/1X5FIOyCvS502daZkkOvqCr3c1G26bNPK/edit?usp=drive_web&ouid=115140681446534846775&rtpof=true**	**https://drive.google.com/drive/folders/1B-TzQsWk9GKopE51AsOmAe6qLN8CuyOe**		analyze		PPT	T1&R1
14			Regenerative Braking operations	**https://docs.google.com/presentation/d/1X5FIOyCvS502daZkkOvqCr3c1G26bNPK/edit?usp=drive_web&ouid=115140681446534846775&rtpof=true**	**https://drive.google.com/drive/folders/1B-TzQsWk9GKopE51AsOmAe6qLN8CuyOe**		Analyze		PPT	T1&R1
15		5	Four quadrant operation of D.C motors by single phase dual converters	**https://docs.google.com/presentation/d/1IWrsdvcRSB8rC-OthtHuK2vaxbyEdPyq/edit#slide=id.p1**	**https://drive.google.com/drive/folders/1B-TzQsWk9GKopE51AsOmAe6qLN8CuyOe**		Understand		PPT	T1&R1
16			Four quadrant operation of D.C motors by three phase dual converters	**https://docs.google.com/presentation/d/1IWrsdvcRSB8rC-OthtHuK2vaxbyEdPyq/edit#slide=id.p1**	**https://drive.google.com/drive/folders/1B-TzQsWk9GKopE51AsOmAe6qLN8CuyOe**		Understand		PPT	T1&R1
17			Closed loop operation of DC motor (Block Diagram Only)	**https://drive.google.com/drive/folders/15VbLEJ7Sq7Undd_WAV9TA0bxCVEDAWxC**	**https://docs.google.com/document/d/126Bk93WO0liT-6N_L3VEdDbut5WIAzjXPai3gcHC6vU/edit**		Understand		PPT	T1&R1
18			Control of DC Motors by Choppers: Single quadrant, Two quadrant chopper fed dc separately excited and series motors	**https://docs.google.com/presentation/d/1RTxDNMTu-UeG-8jGJfXIgcekfrxCKbS3/edit#slide=id.p10**	**https://docs.google.com/document/d/1cbSkGW3Es0UL51t0D_uOpri1gHETwtqlu77ISg0uvhc/edit**		Understand		PPT	T1&R1
19		6	Four quadrant chopper fed dc separately excited and series motors	**https://docs.google.com/presentation/d/1RTxDNMTu-UeG-8jGJfXIgcekfrxCKbS3/edit#slide=id.p10**	**https://docs.google.com/document/d/1cbSkGW3Es0UL51t0D_uOpri1gHETwtqlu77ISg0uvhc/edit**		Understand		PPT	T1&R1

20			Continuous current operation,Output voltage and current wave forms	**https://docs.google.com/presentation/d/1IWrsdvcRSB8rC-OthtHuK2vaxbyEdPyq/edit#slide=id.p1**	**https://docs.google.com/document/d/1cbSkGW3Es0UL51t0D_uOpri1gHETwtqlu77ISg0uvhc/edit**		Understand		PPT	T1 & R1
21			Speed and torque expressions,Speed – Torque characteristics	**https://docs.google.com/presentation/d/1IWrsdvcRSB8rC-OthtHuK2vaxbyEdPyq/edit#slide=id.p1**	**https://docs.google.com/document/d/1cbSkGW3Es0UL51t0D_uOpri1gHETwtqlu77ISg0uvhc/edit**		Understand		PPT	T1 & R1
22			Problems on Chopper fed D.C Motors	**https://docs.google.com/presentation/d/1IWrsdvcRSB8rC-OthtHuK2vaxbyEdPyq/edit#slide=id.p1**	**https://docs.google.com/document/d/1xrgUVeQolF_3IcqMHIfTEmej4ksWwPRyWmHjPwD1v4U/edit**		Understand		PPT	T1 & R1
23			Numerical problems	**https://docs.google.com/presentation/d/1IWrsdvcRSB8rC-OthtHuK2vaxbyEdPyq/edit#slide=id.p1**			analyze		PPT	T1 & R1
24			**Prsentaion Hour**				Analyze		PPT	T1 & R1
25			**UNIT 3: Control of Induction Motor** Through Stator Voltage And Stator Frequency: Variable voltage characteristics	https://docs.google.com/presentation/d/1LGQGvXZiou_fNf2_XWnW9PWzded-Qhi1/edit#slide=id.p1	https://drive.google.com/drive/folders/15Xbq5JhPFTmgJqApc3Pb12sqskz-y4vw		Analyze		PPT	T1 & R1
26		8	Control of Induction Motor by AC Voltage Controllers	https://docs.google.com/presentation/d/1LGQGvXZiou_fNf2_XWnW9PWzded-Qhi1/edit#slide=id.p1	https://drive.google.com/drive/folders/15Xbq5JhPFTmgJqApc3Pb12sqskz-y4vw	https://drive.google.com/drive/folders/1Pa5f07ccuxnv51M4aN2TkscTfqW5uUlr	analyze	CO3	PPT	T1 & R1
27			Waveforms – speed torque characteristics	https://docs.google.com/presentation/d/1LGQGvXZiou_fNf2_XWnW9PWzded-Qhi1/edit#slide=id.p1	https://drive.google.com/drive/folders/15Xbq5JhPFTmgJqApc3Pb12sqskz-y4vw		analyze		PPT	T1 & R1
28		9	Variable frequency characteristics	https://docs.google.com/presentation/d/1zF0f-wu5vWcumvA5CASw-Zi1tBtk56m3/edit#slide=id.p1	https://drive.google.com/drive/folders/15Xbq5JhPFTmgJqApc3Pb12sqskz-y4vw		analyze		PPT	T1 & R1
29			Variable frequency control of induction motor by Voltage source and current source inverter and cyclo converters	https://docs.google.com/presentation/d/1zF0f-wu5vWcumvA5CASw-Zi1tBtk56m3/edit#sli	https://drive.google.com/drive/folders/15Xbq5JhPFTmgJqApc3Pb12sqskz-y4vw		analyze		PPT	T1 & R1

				de=id.p1						
30			PWM control	https://docs.google.com/presentation/d/1U-mXRonp2l3CveNMb3loJSFltMEjmXcf/edit#slide=id.p1	https://drive.google.com/drive/folders/15Xbq5JhPFTmgJqApc3Pb12sqskz-y4vw		analyze		PPT	T1&R1
31			Comparison of VSI and CSI operations	https://docs.google.com/presentation/d/1U-mXRonp2l3CveNMb3loJSFltMEjmXcf/edit#slide=id.p1	https://drive.google.com/drive/folders/15Xbq5JhPFTmgJqApc3Pb12sqskz-y4vw		analyze		PPT	T1&R1
32		10	Speed torque characteristics	https://docs.google.com/presentation/d/1U-mXRonp2l3CveNMb3loJSFltMEjmXcf/edit#slide=id.p1	https://drive.google.com/drive/folders/15Xbq5JhPFTmgJqApc3Pb12sqskz-y4vw		analyze		PPT	T1&R1
33			Numerical problems on induction motor drives	https://drive.google.com/drive/folders/1Pa5f07ccuxnv51M4aN2TkscTfqW5uUlr	https://drive.google.com/drive/folders/1Pa5f07ccuxnv51M4aN2TkscTfqW5uUlr		Understand		PPT	T1&R1
34			Closed loop operation of induction motor drives (Block Diagram Only)	https://docs.google.com/presentation/d/1C5lQKFB1nD5iU5wGlbjbxr0TVNJguaQB/edit?usp=drive_web&ouid=115140681446534846775&rtpof=true	https://drive.google.com/drive/folders/15Xbq5JhPFTmgJqApc3Pb12sqskz-y4vw		Understand		PPT	T1&R1
35			**Presentaion Hour**				Understand		PPT	T1&R1
36		11	**UNIT 4: Rotor Side Control of Induction Motor**: Static rotor resistance control	https://docs.google.com/presentation/d/1MVtiKpngg_fOK6xSPUpuwG5-UpuUK3ZL/edit?usp=drive_web&ouid=115140681446534846775&rtpof=true	https://drive.google.com/drive/folders/1M_7_i6Rzr5e4dDmP3cIbCCeseGXY_syY		Understand		PPT	T1&R1
37			Slip power recovery	https://docs.google.com/presentation/d/1cTx9JG0qSIUK_c9nXpbZHqmtMLtx0wwY/edit?usp=drive_web&ouid=115140681446534846775&rtpof=true	https://drive.google.com/drive/folders/1M_7_i6Rzr5e4dDmP3cIbCCeseGXY_syY	https://drive.google.com/drive/folders/1Pa5f07ccuxnv51M4aN2TkscTfqW5uUlr	Understand		PPT	T1&R1
38			Static Scherbius drive performance and speed torque characteristics	https://docs.google.com/presentation/d/1cTx9JG0qSIUK_c9nXpbZHqmtMLtx0wwY/edit?usp=drive_web&ouid=11514068144653	https://drive.google.com/drive/folders/1M_7_i6Rzr5e4dDmP3cIbCCeseGXY_syY		Understand		PPT	T1&R1

				34846775&rtpof=true						
39			Static Scherbius drive advantages, applications, problems	https://docs.google.com/presentation/d/1cTx9JG0qSIUK_c9nXpbZHqmtMLtx0wwY/edit?usp=drive_web&ouid=115140681446534846775&rtpof=true	https://drive.google.com/drive/folders/1M_7_i6Rzr5e4dDmP3cIbCCeseGXY_syY		Understand	CO4	PPT	T1&R1
40		12	Static Kramer Drive performance and speed torque characteristics	https://docs.google.com/presentation/d/1cTx9JG0qSIUK_c9nXpbZHqmtMLtx0wwY/edit?usp=drive_web&ouid=115140681446534846775&rtpof=true	https://drive.google.com/drive/folders/1M_7_i6Rzr5e4dDmP3cIbCCeseGXY_syY		Understand		PPT	T1&R1
41			Static Kramer Drive advantages, applications, problems	https://docs.google.com/presentation/d/1cTx9JG0qSIUK_c9nXpbZHqmtMLtx0wwY/edit?usp=drive_web&ouid=115140681446534846775&rtpof=true	https://drive.google.com/drive/folders/1M_7_i6Rzr5e4dDmP3cIbCCeseGXY_syY		Understand		PPT	T1&R1
42			Problems	https://drive.google.com/drive/folders/1Pa5f07ccuxnv51M4aN2TkscTfqW5uUlr	https://drive.google.com/drive/folders/1M_7_i6Rzr5e4dDmP3cIbCCeseGXY_syY		Understand		PPT	T1&R1
43			**Presentaion Hour**				Understand		PPT	T1&R1
44			**UNIT 5: Control of Synchronous Motors**: Separate control and self control of synchronous motors	**https://docs.google.com/presentation/d/1_Of-svBRn41RfZnBuEu9EXzVlsOvabQS/edit?usp=drive_web&ouid=115140681446534846775&rtpof=true**	**https://drive.google.com/drive/u/0/folders/1nyY3bXcBlj_hQyWdwxdbFLOTybCVRuj6**	https://drive.google.com/drive/u/0/folders/1Pa5f07ccuxnv51M4aN2TkscTfqW5uUlr	Understand	CO5	PPT	T1&R1
45		14	Operation of self controlled synchronous motors by VSI, CSI and cyclo converters	**https://docs.google.com/presentation/d/1_Of-svBRn41RfZnBuEu9EXzVlsOvabQS/edit?usp=drive_web&ouid=115140681446534846775&rtpof=true**	**https://drive.google.com/drive/u/0/folders/1nyY3bXcBlj_hQyWdwxdbFLOTybCVRuj6**		Understand		PPT	T1&R1
46			Load commutated CSI fed Synchronous MotorOperation – Waveforms	**https://docs.google.com/presentation/d/1_Of-svBRn41RfZnBuEu9EXzVlsOvabQS/edit?usp=drive_web&o**	**https://drive.google.com/drive/u/0/folders/1nyY3bXcBlj_hQyWdwxdbFLOTybCVRuj6**		Understand		PPT	T1&R1

				uid=115140681446534846775&rtpof=true						
47			Load commutated CSI fed Synchronous Motor speed torque characteristics – Applications	https://docs.google.com/presentation/d/1_Of-svBRn41RfZnBuEu9EXzVlsOvabQS/edit?usp=drive_web&ouid=115140681446534846775&rtpof=true	https://drive.google.com/drive/u/0/folders/1nyY3bXcBlj_hQyWdwxdbFLOTybCVRuj6		Understand		PPT	T1&R1
48			Load commutated CSI fed Synchronous Motor Advantages and Numerical Problems	https://docs.google.com/presentation/d/10xQMLIt6w4oI9Dn_a216XnwR8qB9pk5f/edit#slide=id.p1	https://drive.google.com/drive/u/0/folders/1nyY3bXcBlj_hQyWdwxdbFLOTybCVRuj6		Understand		PPT	T1&R1
49			**Presentaion Hour**				Understand		PPT	T1&R1
50		15	Closed Loop control operation of synchronous motor drives (Block Diagram Only)	https://docs.google.com/presentation/d/10xQMLIt6w4oI9Dn_a216XnwR8qB9pk5f/edit#slide=id.p1	https://drive.google.com/drive/u/0/folders/1nyY3bXcBlj_hQyWdwxdbFLOTybCVRuj6		Understand		PPT	T1&R1
51			Variable frequency control	https://docs.google.com/presentation/d/10xQMLIt6w4oI9Dn_a216XnwR8qB9pk5f/edit#slide=id.p1	https://drive.google.com/drive/u/0/folders/1nyY3bXcBlj_hQyWdwxdbFLOTybCVRuj6		Understand		PPT	T1&R1
52			Cyclo converter	https://docs.google.com/presentation/d/10xQMLIt6w4oI9Dn_a216XnwR8qB9pk5f/edit#slide=id.p1	https://drive.google.com/drive/u/0/folders/1nyY3bXcBlj_hQyWdwxdbFLOTybCVRuj6		Understand		PPT	T1&R1
53		16	PWM based VSI & CSI	https://docs.google.com/presentation/d/10xQMLIt6w4oI9Dn_a216XnwR8qB9pk5f/edit#slide=id.p1	https://drive.google.com/drive/u/0/folders/1nyY3bXcBlj_hQyWdwxdbFLOTybCVRuj6		Understand		PPT	T1&R1

TEXT BOOKS:

1. "G K Dubey", Fundamentals of Electric Drives, CRC Press, 2002.
2. "Vedam Subramanyam", Thyristor Control of Electric drives, Tata McGraw Hill Publications, 1987.

REFERENCE BOOKS:

1. "S K Pillai", A First course on Electrical Drives, New Age International (P) Ltd. 2nd Edition. 1989
2. "P. C. Sen", Thyristor DC Drives, Wiley-Blackwell, 1981
3. "B. K. Bose", Modern Power Electronics, and AC Drives, Pearson 2015

***Content beyond Syllabus**

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

Co	Program Outcomes (PO)	Program

urse Outcomes													Specific Outcomes (PSO)	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	-	-	1	1	1	-	-	-	-	2	2
CO2	3	3	2	-	-	1	1	1	-	-	-	-	2	2
CO3	3	2	2	2	2	-	-	2	-	-	-	-	3	2
CO4	3	2	2	-	1	-	2	-	-	1	-	1	2	2
CO5	3	3	2	-	2	-	-	2	1	-	-	2	3	2
AVG	3	2.4	2	2	1.67	1	1	1.5	1	1	-	1.5	2.4	2

3:Substantial (High) - : None

X. QUESTION BANK (JNTUH)

UNIT I

Long Answer Questions-

S.No	Question	Blooms Taxonomy Level	Course Outcome
1	Derive an expression relating speed and torque of a single phase full converter fed separately excited DC motor drive operating in the continuous current mode	Understand	1, 2, & 3
2	Analyze and describe the operation of single phase fully controlled rectifier control of DC series motor and obtain the expression for motor speed for continuous mode of operation	Analyze	1, & 3
3	Explain the use of freewheeling diode in the converter fed DC drives. Take an example of 1-phase fully controlled converter fed for explanation. How it is going to affect the machine performance.	Analyze	1, 2 & 3
4	Describe the operation of single phase semi controlled rectifier control of DC series motor and obtain the expression for motor speed for continuous mode of operation	Analyze	1, 2, & 3
5	Derive an expression for an average output voltage of a 1-phase semi-converter. Assuming a very highly inductive load, draw the waveforms of output voltage, load current and voltage across thyristors	Analyze	1, 2 & 3
6	Explain the operation of three phase full controlled rectifier fed dc series motor drives with waveforms and characteristics	Understand	1, 2 & 3
7	Compare three phase drives and single phase drives	Analyze	1, 2& 3
8	A single phase fully controlled thyristor converter is supplying a DC separately excited DC motor. Draw the neat waveforms diagrams and explain various operating modes of the drive Both in motoring and regenerative braking for (a) $\gamma < \alpha$ (b) $\gamma > \alpha$ Where α is the firing angle, γ is the angle at which the source voltage equal to the motor back emf. Assume the armature of the separately excited dc motor can be replaced by simple R-L and back emf load	Compute	1, 2 & 3
9	Explain the operation of three phase half controlled rectifier fed dc separately excited DC motor drives with waveforms and characteristics	Understand	1 & 3
10	Explain the motoring and braking operation of three phase fully controlled rectifier control of dc separately excited motor with aid of diagrams and waveforms. Also obtain the expression for motor terminal	Analyze	1 & 3

	voltage speed.		

Short Answer Questions-

S.No	Question	Blooms Taxonomy Level	Course Outcome
1	List out the drawbacks of rectifier fed DC drive.	Understand	2
2	Mention the different factors for the selection of electric drives?	Analyze	1 & 2
3	List the applications of electrical drives	Understand	1
4	What are the advantages of three phase controlled converter fed DC Drives	Understand	3
5	A separately excited dc motor is required to be controlled from a 3-phase source for operation in the first quadrant only. The most preferred converter	Analyze	2 & 3

UNIT II

Long Answer Questions-

S. N0	Question	Blooms Taxonomy Level	Course Outcome
1	What is 4-quadrant operation and explain with converters.	Understand	3
2	What is a dual converter? Explain the principle of operation of a dual converter in a circulating current mode. How the same is used for speed control of DC drive	Apply	2 & 3
3	Explain how four-quadrant operation is achieved by dual converter each of 1ϕ full wave configuration for DC separately excited motor.	Apply	2 & 3
4	Explain the principle of closed-loop control of a DC drive using suitable block diagram.	Understand	2 & 3
5	Draw and explain the torque-speed characteristics for dynamic braking operation of DC series motor. Why torque becomes zero at finite speed	Analyze	1 & 2
6	Explain the different types of control strategies of DC chopper.	Understand	3
7	With a neat diagram, explain the operation of a DC drive in all four quadrants when fed by a single phase dual converter with necessary waveforms and characteristics.	Understand	1 & 3
8	Draw the circuit diagram and explain the operation of closed loop speed control with inner-current loop and field weakening	Apply	2 & 3
9	List types of control strategies of Dc chopper?	Understand	3
10	Electrical braking of series motor is not straight forward as that of a separately excited DC motors – Justify	Evaluate	2 & 3

Short Answer Questions-

S. No	Question	Blooms Taxonomy Level	Course Outcome
1	Which braking is suitable for reversing the motor?	Analyze	1 & 2
2	List the advantages of closed loop operation.	Understand	2
3	What are the conditions for the operation of motor in regenerative braking	Understand	1 & 2
4	What is the operation of converter in third and fourth quadrants	Understand	1 & 2

5	List types of control strategies of Dc chopper?	Understand	3

UNIT III

Long Answer Questions-

S.No	Question	Blooms Taxonomy Level	Course Outcome
1	Why stator voltage control is an inefficient method of induction motor speed control	Analyze	2 & 3
2	Draw a closed loop block diagram for the above speed control technique. Mention the merits of the above method of speed control	Understand	1 & 2
3	Explain the mechanical characteristics of a three phase induction motor with stator frequency control.	Understand	2 & 3
4	Explain in detail the speed control scheme for a three phase induction motor using PWM inverter.	Understand	2 & 3
5	Constant torque loads are not suitable for AC voltage controller fed induction motor drive. Why?	Analyze	2 & 3
6	Explain in detail the voltage source inverter control of induction motor drive.	Understand	3 & 4
7.	Explain the closed-loop speed control and converter rating for VSI and cycloconverter induction motor drives.	Understand	3 & 4
8.	A Y-connected squirrel-cage induction motor has following rating parameters: 400 V, 50 Hz, 4-pole, 1370 rpm, $R_s = 2\Omega, R_r^{'} = 3\Omega, X_s = X_r^{'} = 3.5\Omega,$ Motor is controlled by a voltage source inverter at constant V/f ratio. Inverter allows frequency variation from 10 to 50 Hz. (i) Obtain aplot between the breakdown torque and frequency. (ii) Calculate starting torque and current of this drive as a ratio of their values when motor is started at rated voltage and frequency.	Evaluate	3 & 4
9.	A 440V, 3 phase, 50Hz 6 pole 945 RPM delta connected induction motor has the following parameters referred to the stator. R1=2.0 Ω, R2 = 2.0 Ω, X1 = 3 Ω, X2 = 4 Ω. When driving a fan load at rated voltage, it runs at rated speed. The motor speed is controlled by stator voltage control. Determine motor terminal voltage, current and torque at 600 RPM.	Evaluate	3 & 4
10.	Explain in detail with speed-torque characteristics of variable voltage and variable frequency (V/F) control of induction motor drive	Understand	3 & 4

Short Answer Questions-

S.No	Question	Blooms Taxonomy Level	Course Outcome
1	Draw the equivalent circuit of an induction motor	Understand	2
2	What are the advantages of variable frequency control?	Understand	2 & 3
3	What are the applications of variable frequency	Understand	2

	drives?		
4	Draw the speed torque characteristics of induction motor	Understand	1 & 2
5	What are the different types of rotor resistances control in induction motor	Understand	1 & 2

UNIT IV

Long Answer Questions-

S.No	Question	Blooms Taxonomy Level	Course Outcome
1	With the help of a neat schematic, discuss the operation of a Static Scherbius drive. Derive the speed-torque expression and draw its speed-torque characteristics.	Understand	1, 2, & 3
2	With the help of a neat schematic discuss the operation of a Static Kramer drive.	Analyze	1, & 3
3	Draw the speed-torque characteristics of induction motor with variable rotor resistance and explain why this method is inefficient.	Analyze	1, 2 & 3
4	With the help of a neat schematic discuss the operation of a Static rotor resistance control method for induction motor speed control.	Analyze	1, 2, & 3
5	440 V, 50 Hz, 6-pole Y-connected wound rotor motor has the following parameters: Rs = 0.5 Ω, Rr' = 0.4 Ω, Xs = Xr' = 1.2 Ω, Xm = 50 Ω, stator to rotor turns ratio is 3.5. Motor is controlled by static rotor resistance control. External resistance is chosen such that the breakdown torque is produced at standstill for a duty ratio of zero. Calculate the value of external resistance.	Compute	1, 2 & 3
6	A three phase, 400V, 6-pole, 50 Hz, delta connected slip ring induction motor has rotor resistance of 0.2 ohms and leakage reactance of 1 ohms per phase referred to stator. When driving a fan load it runs at full load of 4% slip. What resistance must be inserted in the rotor circuit to obtain a speed of 850 rpm. Neglect stator impedance and magnetizing branch. Stator to rotor turns ratio is 2.2.	Compute	2, 3 & 5
7	A 400V, 50 Hz, 950rpm, 6-pole, star connected, three phase wound rotor induction motor has following parameters referred to the stator: Rs = 0.2 Ω, Rr' = 0. 07 Ω, Xs = 0.4 Ω, Xr' = 0.4 Ω, the stator to rotor turns ration is 2. Motor speed is controlled by static scherbius drive. Drive is designed for a speed range of 25% below the synchronous speed. Maximum value of firing angle is 150°. Calculate (i) Turns ratio of transformer (ii) Torque for a speed of 750 rpm and α=130°.	Compute	3, 4 & 5
8	A 440V, 50 Hz, 970rpm, 6-pole, star connected, three phase wound rotor induction motor has following parameters referred to the stator: Rs = 0.1 Ω, Rr' = 0.08 Ω, Xs=0.3 Ω, Xr' = 0.4 Ω, the stator to rotor turns ration is 2. Motor speed is controlled by static scherbius drive. Drive is designed for a speed range of 25% below the synchronous speed. Maximum value of firing angle is 165°. Calculate (i) Turns ratio of transformer. (ii) Torque for a speed of 780 rpm and α=140°.	Compute	3, 4 & 5

9	Explain the speed control and performance characteristics of static Kramer's drive.	Understand	1 & 3
10	Describe the static rotor resistance control for speed control of an induction motor.	Analyze	1 & 3

Short Answer Questions-

S.No	Question	Blooms Taxonomy Level	Course Outcome
1	What are the advantages of static rotor resistance control over conventional methods of rotor resistance control?	Understand	4
2	Explain speed –torque characteristics of a static Scherbius drive control for speed control of induction motor.	Understand	3 & 4
3	What is slip-power recovery scheme ?	Understand	3
4	Why the slip-power recovery scheme is suitable mainly for druves with a low speed ranges ?	Understand	3 & 4
5	Why has the Static Kramer Drive a low range of speed control ?	Understand	3 & 4

UNIT V

Long Answer Questions-

S.No	Question	Blooms Taxonomy Level	Course Outcome
1	What is the difference between true synchronous mode and self control mode for variable frequency control of synchronous motor?	Understand	1, 2, & 3
2	Explain closed loop control operation of a synchronous motor drive.	Analyze	1, & 3
3	Explain the operation of self-controlled synchronous motor drive using VSI.	Analyze	1, 2 & 3
4	Explain how operation of a synchronous motor shifts from motoring to regenerative braking..	Analyze	1, 2, & 3
5	A 400 kW, three-phase, 3.3 kV, 50 Hz, unity power factor, four-pole, star-connected synchronous motor has the following parameters: Ra=0, Xs= 12Ω, rated field current =10 A. The machine is controlled by variable frequency control at a constant V/f ratio. Calculate: (i) The torque and field current for rated armature current, 900 rpm and 0.8 leading power factor, and (ii) The armature current and power factor for regenerative braking torque equal to rated motor torque, 900 rpm and rated field current.	Compute	1, 2 & 3
6	Describe the operation of self-controlled Synchronous Motor drives in detail.	Compute	1, 2 & 3
7	Explain closed loop speed control of synchronous motor drive fed from CSI.	Compute	1, 2& 3
8	Describe the operation of separate controlled Synchronous Motor drives in detail.	Compute	1, 2 & 3
9	Draw the block diagram and explain the operation of Load commutated VSI fed Synchronous motor drive.	Understand	1 & 3
10	Explain variable frequency speed control of synchronous motor.	Analyze	1 & 3

Short Answer Questions-

S.No	Question	Blooms Taxonomy Level	Course Outcome
1	What is the basic difference between true synchronous mode and self control mode for variable frequency control of synchronous motor ?	Understand	2
2	Why a self-controlled synchronous motor is free from hunting oscillation ?	Understand	2 & 3
3	Why the load commutated inverter fed synchronous motor drive is found suitable for high speed and high power applications ?	Understand	2
4	When operating in true synchronous mode, why the frequency must be changed in small steps ?	Understand	1 & 2
5	Why a cycloconverter controlled synchronous motor (or induction motor) drive is preferred over inverter controlled synchronous motor (or induction motor) drive for low speed applications ?	Understand	1 & 2

OBJECTIVE QUESTIONS:
FILL IN THE BLANKS:

UNIT-1

1. Single Phase Fully Controlled Converter Fed Separately Excited D.C Motor Drive armature voltage is _____

Answer : $\left(\frac{2\sqrt{2}}{\pi}V\cos\alpha\right)$

2. Three Phase Fully Controlled Converter Fed Separately Excited D.C Motor Drive average voltage is _____

Answer : $\left(\frac{3\sqrt{3}}{\pi}V_m\cos\alpha\right)$

3. Seperatly excited DC motor Speed torque realtionship.

Answer : $\left(\frac{V_a}{K_a\varphi}-\frac{R_a}{(K_a\phi)^2}T\right)$

4. The requirements of an electric drive_____

Answer :Stable operation should be assured and drive should have good transient response

5. The applications of electrical drives_____

Answer: Paper mills, Electric traction Cement mills &Steel mills

6. The different types of classes of duty_____

Answer : Continuous duty, Discontinuous duty, Short time duty, intermittent duty

7. _____ is the speed that separates continuous conduction from discontinuous conduction mode.

Answer : Critical Speed

8. The different types of electrical drives_____

Answer : DC and AC Drives

9. The different types of drives _____

Answer : Group drive, Individual drive & Multimotor drive

10. Systems employed for motion control are called _____

Answer: Drives

UNIT-II

1.The types of braking____,____,____

Answer: Regenerative braking, Dynamic braking, & Plugging

2._____occurs when the motor speed exceeds the synchronous speed.
Answer: Regenerative braking
3.The types of control strategies in dc chopper _____
Answer: Time ratio control & Current limit control
4.The advantages of closed loop control of dc drives _____
Answer: Improved accuracy, fast dynamic response and reduced effects of disturbance and system non-linearities

5._____ is used for load equalization.
Answer: Flywheel
6. The drawbacks of rectifier fed dc drives ____
Answer: Distortion of supply, Low power factor & Ripple in motor current
7. The disadvantage of _____is the presence of a mechanical commutator which limits the maximum power rating and the speed
Answer: DC Drives
8. Motor can provide motoring and braking operations for both forward and reverse directions is ____
Answer: four quadrant operations
9. _____occurs when the energy stored in the rotating mass is dissipated in an electrical resistance
Answer: Dynamic braking
10. When phase sequence of supply of the motor running at the speed is reversed by interchanging connections of any two phases of stator with respect to supply terminals, operation shifts from motoring to_____
Answer: plugging region.

UNIT-III

1. The applications of ac drives are ___.
Ans: fans, blowers, mill run-out tables, cranes, conveyors, traction etc
2. The three regions in the speed-torque characteristics in the IM_____.
Ans: Motoring region (0<=s<=1), Generating region(s<0), Plugging region (1<=s<=2) where s is the slip
3. The advantages of stator voltage control method_____
Ans : The control circuitry is simple, Compact size & Quick response time
4_____stepless control of supply voltage from zero to rated voltage they are used for soft start for motors.
Ans : AC voltage controllers
5. The advantages of V/f control_____
Ans : Smooth speed ctrl, Small input current and improved power factor at low frequency start & Higher starting torque.
6 . The main drawback of stepped wave inverter is the ----------in the output voltage.
Ans. Large harmonics of low frequency
7. Harmonics content in motor current increases at----------
Ans. Low speed
8. The harmonic in the motor current produce ---------- and derate the motor.
Ans: torque pulsation
9. Cycloconverter employs large number of thyristors, it becomes economically acceptable only in----------.
Ans: large power drives
10. Because of large inductance in the dc link and large inverter capacitors, CSI drive
Ans: has higher cost, weight and volume, lower speed range and slower dynamic response

UNIT-IV

1. Advantage of rotor resistance control is that motor torque capability remains unaltered even at
Ans: low speed
2. Because of low cost and high torque capability at low speeds, rotor rresistance control is employed in
Ans: cranes, Ward Leonard drives.
3. Compared to conventional rotor resistance control, static resistance control has several advantages such as

Ans: smooth and stepless control, fast response, less maintenance, compact size.

4. For the speed control of a wound rotor motor below and above synchronous speed---------- is used.
   Ans: Static Scherbius Drive
5. The ---------system is used in large power pumps and fan type drives system where the range of speed is limited below synchronous speed.
   Ans: static karmer drive
6. The system with ---------- can be controlled for motoring and regenerting in both the synchronous and subsynchronous speeds
   Ans: bidirectional slip power flow
7. Rotor slip power is converted into dc by a
   Ans: diode bridge
8. In rotor resistance control method of speed control, the slip power is wasted in the ----------and hence the efficiency reduces.
   Ans: external resistance
9. Advantages of rotor resistance control methods are
   Ans: Smooth and stepless control is possible, Quick response, Less maintenance and Compact size
10. Increase in rotor resistance leads to increase of ----------in the rotor resistance. This will reduce the system efficiency.
    Ans: power loss

UNIT-V

1. The speed of a synchronous motor can be controlled by varying ----------of its source.
   Ans; frequency

2. In true synchronous mode of synchronous motor,the stator supply frequency is controlled from an
   Ans: independent oscillator.
3. In self-control mode, the stator supply frequency is changed so that synchronous speed is the same as
   Ans: rotor speed
4. Load side converter performs somewhat similar function as----------
   Ans: commutator in a dc machine
5. When synchronous motor is over excited they can supply the ----------required for commutation thyristors.
   Ans: reactive power
6. When firing angles are changed such that ---------- and ----------, the load side converter operates as a rectifier and source side converter operates as an inverter
   Ans: $90^o \le \alpha_s \le 180^o$, $0^o \le \alpha_l \le 90^o$
7. Synchronous motor speed can be changed by control of line side converter----------
   Ans: firing angles
8. When the firing angle range----------, it acts as a commutated fully controlled rectifier.
   Ans: $0^o \le \alpha_s \le 90^o$
9. The self controlled motor run has properties of a dc motor both under steady state and dynamic conditions and therefore, is called----------.
   Ans: commutator less motor
10. Permanent magnet synchronous motor is used for ----------
    Ans: medium power drives

Multiple Choice Questions:

UNIT I

1. The basic elements of a electric drive are

a) electric motor

b) control system

c) electrical motor and control system
d) none
Answer : c

2. Ward-Leonard controlled D.C. drives are generally used for _____ excavators

a) Light duty

b) Medium duty

c) Heavy duty

d) all of the above
Answer : c

3. The selection of an electric motor for any application depends on which of the following factors ?

a) Electrical characteristics

b) Mechanical characteristics

c) Size and rating of motors
d) Cost
e) all of the above
Answer : e

4. ----------is preferred for automatic drives
a) Squirrel cage induction motor
b) Synchronous motors
c) Ward-Leonard controlled D.C. motors
d) Any of the above
Answer: c

5. Which of the following motors is preferred when quick speed reversal is the main consideration ?
a) Squirrel cage induction motor
b) Wound rotor induction motor
c) Synchronous motor
d) D.C. motor
Answer: d

6) Switchable Speed drive, Open Loop speed drive, closed loop speed drives are the example of
a) Fixed speed Drive
b) Variable Speed drive
c) Servo Drive
d) Any of the above
Answer: b

7) The advantages of a group driver electric drive are
a) Constant speed
b) High efficiency
c) Low Noise
d) all of the above
Answer: b

8) The drive which is used for metal-cutting machines tools, rolling mills etc. are
a) Individual drive

b) Group Drive
c) Multimotor drive
d) None of the above
Answer: c

9) Electric drive is becoming more and more popular because
a) it provide smooth and easy control
b) it is cheaper in cost
c) it is simple and reliable
d) all of the above
Answer: d

10) Which of the following motor is best suitable for rolling mills?
a) Squirrel cage induction motor
b) Wound rotor induction motor
c) Synchronous motor
d) D.C. motor
Answer:d

UNIT II

1. A four quadrant operation requires

a) two full converters in series

b) two full converters connected in parallel

c) two full converter connected in back to back

d) two semi converters connected in back to back
Answer : C

2. In 4 quadrant operation of a hoist 3rd quadrant represents
a) reverse motoring
b) reverse braking
c) forward braking
d) forward motoring
Answer: a

3. Which braking is not possible in series motor?
a) Regenerative braking
b) Dynamic braking
c) Counter electric current braking
d) Rheostat braking
Answer: a

4. An elevator drive is required to operate in
a) one quadrant only
b) two quadrants
c) three quadrants
d) four quadrants
Answer: d

5. In industries which electrical braking is preferred?
a) Regenerative braking
b) Dynamic braking
c) Plugging
d) None of the above
Answer: a

6. High braking torque produced in

a) plugging
b) dynamic braking
c) regenerative braking
d) none of above
Answer: a

7. Polarity of supply voltage is reversed in which type of braking?
a) Regenerative braking
b) Dynamic braking
c) Plugging
d) none of the above
Answer: c

8. For the high-frequency choppers, the device that is preferred is
a) TRIAC
b) Thyristor
c) Transistor
d) GTO
Answer: c

9. Speed control by variation of field flux results in
a) constant power drive
b) constant torque drive
c) variable power drive
d) none of the above
Answer: a

10. To save energy during braking----------braking is used
a) dynamic
b) regenerative
c) plugging
d) all of the above
answer: b

UNIT III

1. For an IM to operate in braking region slip should be always
a) less than zero
b) greater than 1
c) is equal to 1
d) none of these
Answer: b

2. Stator voltage control for speed control of induction motors is suitable for
a) fan and pump drives
b) drive of a crane
c) running it as generator
d) constant load drive
Answer: a

3. In motor circuit static frequency changers are used for
a) power factor improvement
b) improved cooling
c) reversal of direction
d) speed regulation
Answer: d

4) V/f is maintained constant in the following case of speed control of induction motor
a) Below base speed with voltage control
b) Below the base speed with frequency control
c) Above base speed with frequency control
d) None of these
Answer: b

5) --------- has the least value of starting torque to full load torque ratio.
a) D.C. shunt motor
b) D.C. series motor
c) Squirrel cage induction motor
d) Slip ring induction motor
Answer: c

6) The slip of an induction motor during DC rheostatic braking is
a) 2 - s
b) 1 - s
c) 2 + s
d) s
Answer: d

7) Motors preferred for rolling mill drive is
(a) DC Motor
(b) AC slip ring Induction Motor
(c) Any of the above
(d) None of the above
Ans: (c)

8) Wound rotor and squirrel-cage motors with the high slip which develop maximum torque at standstill are used for
(a) Presses and Punches
(b)Machine tools
(c) Elevators
(d) All of the above
Ans: (a)

9) In case of a 3 phase induction motor, plugging is done by:
(a) Starting the motor on load which is more than the rated load
(b) Pulling the motor directly on line without a starter
(c)Interchanging connections of any two phases of the stator for quick stopping
(d) Locking of the rotor due to harmonics
Ans: (c)

10) In a 3-phase voltage source inverter used for speed control of induction motor, antiparallel diodes are used across each switching device. The main purpose of diodes is to:
(a) Protect the switching devices against overvoltage
(b) Provide the path for freewheeling current
(c) Allow the motor to return energy during regeneration
(d) Help in switching off the devices
Ans : (c)

UNIT IV

1) In case of traveling cranes, the motor preferred for boom hoist
(a) AC Slip Ring Motor
(b) Ward Leonard Controlled DC Shunt Motor
(c) Synchronous Motor
(d) Single Phase Motor

Ans (a)

2) Under which of the following condition the squirrel cage induction motor is preferred over the wound rotor induction motor.?
(a) When an external voltage is to be necessarily into the rotor
(b) When the wide range of speed control is required
(c) When the cost is the major consideration
(d) When higher starting torque is required
Ans: (c)

3) As an energy efficient application, slip power recovery system fits well for
(a) Squirrel cage and slip ring motors
(b) DC motor
(c) Slip ring motors only
(d) None of the above
Ans: (c)

4) Fans, pumps, Blowers are the example of _____ drive
(a) Fixed speed Drive
(b) Variable Speed drive
(c) Servo Drive
(d) Any of the above
Ans: (b)

5) Switchable Speed drive, Open Loop speed drive, closed loop speed drives are the example of
(a) Fixed speed Drive
(b) Variable Speed drive
(c) Servo Drive
(d) Any of the above
Ans: (b)

6) In the method of speed control of an induction motor by inducing EMF in the rotor circuit, if the injected voltage is in the phase opposition to the induced rotor EMF, then
(a) The rotor resistance Increase
(b) The rotor reactance increase
(c) The rotor reactance decrease
(d) The rotor resistance decrease
Ans: (a)

7) During the starting of a slip ring induction motor using rotor resistance starter, the insertion of resistance in the rotor circuit causes:
(a) Stator current to Increase and torque to decrease
(b) Stator current to decrease and torque to increase
(c) Stators current to Increase and power factor to decrease
(d) Power factor to decrease and torque to Increase
Ans: (b)

8) A three-phase induction motor is analogous to
(a) Generator
(b) Rotating transformer
(c) Rotating Motor
(d) Rotating converter
(e) **Ans: (b)**

9) If any two phases for an induction motor are interchanged
(a) The motor will run in reverse direction

(b) The motor will continue to run in the same direction

(c) The motor will stop

(d) The motor will Burn

Ans: (a)

10)Blocked rotor test in an induction motor is used to determine

(a) Leakage impedance

(b) Copper loss

(c) Both 1 & 2

(d) None of the above

Ans: (c)

UNIT V

1) As compared to three phase induction motor the advantage of synchronous Motor in addition to its constant speed is

(a) Higher Power factor

(b) Better efficiency

(c) Both 1 & 2

(d) None of the above

Ans: (c)

2) In motor, the static frequency changers are used for

(a) Power factor management

(b) Improved cooling

(c) Reversal of direction

(d) Speed Regulation

Ans: (d)

In a self-controlled synchronous motor fed from a variable frequency inverter

(a) The rotor poles invariably have damper windings

(b) There are stability problems

(c) The speed of the rotor decides stator frequency

(d) The frequency of the stator decides the rotor speed

Ans: (d)

3) What happens if field winding of the synchronous motor is short circuited?

(a) First, starts as induction motor then run as synchronous motor

(b) Not start

(c) Motor will burn out

(d) Run as induction motor

Ans: (d)

4) In a synchronous motor, during hunting when the rotor speed exceeds the synchronous speed then damper bar develop

(a) Induction generator torque

(b) Harmonic

(c) DC motor torque

(d)Synchronous motor torque

Ans: (a)

5) A 3 phase, salient pole synchronous motor is fed from an infinite bus and is running at no load. Now if the field current of the motor is reduced to zero then the

(a) Motor will run at synchronous speed

(b) Motor will stop

(c) Motor will run at low speed

(d) Motor will burn
Ans: (c)

6) Which of the following motor is not self-starting?
(a) Wound rotor induction motor
(b) Squirrel cage induction motor
(c) DC series motor
(d) Synchronous motor
Ans: (d)

7) In a synchronous motor, the synchronizing power comes into action when
(a) Rotor speed is less than synchronous speed
(b) Rotor speed is more than synchronous speed
(c) Rotor speed is equal to synchronous speed
(d) Rotor speed is either less or more than synchronous speed
Ans: (d)

8) In a synchronous motor which loss does not vary with the load?
(a) Windage losses
(b) Copper losses
(c) Hysteresis losses
(d) None of the above
Ans: (a)

9) The maximum value of torque that a synchronous motor, can develop without losing its synchronism, is known as
(a) Pull out torque
(b) Breaking torque
(c) Slip torque
(d) Non-synchronizing torque
Ans: (a)

EXPERT DETAILS:

1. **Dr. Srinivasa Rao Sandepudi**
   Professor and HEAD, Department of Electrical Engineering
   NIT Warangal

2. **Dr. K. Siva Kumar**
   Associate Professor, Department of Electrical Engineering
   IIT Hyderabad

WEBSITES:

1. http://www.iosrjournals.org/iosr-jeee/Papers/ICAET-2014/electrical/volume 1/8.pdf?id=7590
2. https://ieeexplore.ieee.org/document/4350
3. https://ieeexplore.ieee.org/document/4643571
4. https://www.academia.edu/31118888/FOUR_QUADRANT_OPERATION_OF_DUAL_CONVERTER_BASED_DC_DRIVES
5. https://www.electrical4u.com/dual-converter/
6. http://www.rgcetpdy.ac.in/Notes/EEE/IV%20YEAR/Solid%20State%20Drives/Unit%202.pdf
7. http://eeedrmcet.zohosites.com/files/Lecture%2016%204%20quadrant%20operation%20of%20chopper.pdf

JOURNALS:

1. www.ieee.org
2. www.springer.com
3. www.sciencedirect.com

LIST OF TOPICS FOR STUDENT SEMINARS:

1. Three-phase half-controlled rectifier control of separately excited motor.
2. Variable frequency control of an induction motor.
3. Closed-loop slip controlled CSI drive with regenerative braking.
4. Performance of rotor resistance control of induction motor.
5. Analysing the performance of slip power recovery drive.
6. Variable frequency control of multiple synchronous motors.

CASE STUDIES/SMALL PROJECTS

1. Design of Single Phase semi and Fully controlled converters connected to d.c separately excited and d.c series motors using Matlab/Simulink.
2. Design self-controlled synchronous motor drive employing load commutated inverter using Matlab/Simulink.
3. Simulation and Comparative Assessment of Slip Power Recovery Scheme using Matlab/Simulink.
4. Study the performance of three-phase semi and fully controlled converters connected to d.c separately excited and d.c series motors using Matlab/Simulink.

==== END ====