Ref No:

Sri krishna Institute of Technology
Bangalore

COURSE PLAN

Academic Year 2019-20

Program:	B E – Electronics & Electronics Engineering
Semester :	8
Course Code:	15EE82
Course Title:	**Industrial Drives and Applications**
Credit / L-T-P:	4 / 4-0-0
Total Contact Hours:	40
Course Plan Author:	Chaitra A S

Academic Evaluation and Monitoring Cell

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Note : Remove “Table of Content” before including in CP Book
Each Course Plan shall be printed and made into a book with cover page
Blooms Level in all sections match with A.2, only if you plan to teach / learn at higher levels

A. COURSE INFORMATION

1. Course Overview

Degree:	BE	Program:	EE
Semester:	8	Academic Year:	2019
Course Title:	Industrial Drives and Applications	Course Code:	15EE82
Credit / L-T-P:	4 / 4-0-0	SEE Duration:	180 Minutes
Total Contact Hours:	40 Hours	SEE Marks:	80 Marks
CIA Marks:	20 Marks	Assignment	1 / Module
Course Plan Author:	Chaitra A S	Sign ..	Dt:
Checked By:		Sign ..	Dt:
CO Targets	CIA Target : ..... %	SEE Target:	..... %

Note: Define CIA and SEE % targets based on previous performance.

2. Course Content

Content / Syllabus of the course as prescribed by University or designed by institute. Identify 2 concepts per module as in G.

Module	Content	Teaching Hours	Identified Module Concepts	Blooms Learning Levels
1	**Electrical Drives**: Electrical Drives, Advantages of Electrical Drives. Parts of Electrical Drives, Choice of Electrical Drives, Status of dc and ac Drives. Dynamics of **Electrical Drives:** Fundamental Torque Equations, Speed Torque Conventions and Multi quadrant Operation. Equivalent Values of Drive Parameters, Components of Load Torques, Nature and Classification of Load Torques, Calculation of Time and Energy Loss in Transient Operations, Steady State Stability, Load Equalization. **Control Electrical Drives:** Modes of Operation, Speed Control and Drive Classifications, Closed loop Control of Drives.	12 (5,7)	Choice of Electric drives Dynamics of Electric drives	L3,L4
2	**Selection of Motor Power Ratings:** Thermal Model of Motor for Heating and Cooling, Classes of Motor Duty, Determination of Motor Rating. **Direct Current Motor Drives:** Controlled Rectifier Fed dc Drives, Single Phase Fully Controlled Rectifier Control of dc Separately Excited Motor, Single Phase Half Controlled Rectifier Control of dc Separately Excited Motor, Three Phase Fully Controlled Rectifier Control of dc Separately Excited Motor, Three Phase Half Controlled Rectifier Control of dc Separately Excited Motor, Multiquadrant Operation of dc Separately Excited Motor Fed Form Fully Controlled Rectifier ,Rectifier Control of dc Series Motor, Supply Harmonics, Power Factor and Ripple in Motor Current, Chopper Control of Separately Excited dc Motor, Chopper Control of Series Motor.	12 (5,7)	selection of motor Power rating Control of DC motor Drives	L3, L4
3	**Induction Motor Drives:** Analysis and Performance of Three Phase Induction Motors, Operation with Unbalanced Source Voltage and Single Phasing, Operation with Unbalanced Rotor Impedances, Analysis of Induction Motor Fed From Non-Sinusoidal Voltage Supply, Starting, Braking, Transient Analysis. Speed Control Techniques-Stator Voltage Control, Variable Voltage Frequency Control from Voltage Sources	12 (5,6)	Operation of Induction motor drives Performance of Induction motor drives	L3,L4
4	**Induction Motor Drives (continued):** Voltage Source Inverter (VSI) Control, Cycloconverter Control, Closed Loop Speed Control and Converter Rating for VSI and Cycloconverter Induction Motor Drives, Variable Frequency Control from a Current Source, Current Source (CSI) Control, current regulated voltage source inverter control, speed control of	11 (5,6)	Control of Induction motor drives	L3,L4

	single phase induction motors. **Synchronous Motor Drives:** Operation from fixed frequency supply-starting, synchronous motor		Performance of Synchronous motor	
5	**Synchronous Motor Drives (continued):** Self-controlled synchronous motor drive employing load commutated thruster inverter, Starting Large Synchronous Machines, Permanent Magnet ac (PMAC) Motor Drives, Sinusoidal PMAC Motor Drives, Brushless dc Motor Drives. **Stepper Motor Drives:** Variable Reluctance, Permanent Magnet, Important Features of Stepper Motors, Torque Versus Stepping rate Characteristics, Drive Circuits for Stepper Motor. **Industrial Drives:** Textile Mills, Steel Rolling Mills, Cranes and Hoists, Machine Tools.	11 (6,5)	Control of synchronous motor drives Industrial Application	L4, L4
-	**Total**	**57**	-	-

3. Course Material

Books & other material as recommended by university (A, B) and additional resources used by course teacher (C).

1. Understanding: Concept simulation / video ; one per concept ; to understand the concepts ; 15 – 30 minutes
2. Design: Simulation and design tools used – software tools used ; Free / open source
3. Research: Recent developments on the concepts – publications in journals; conferences etc.

Modules	Details	Chapters in book	Availability
A	**Text books (Title, Authors, Edition, Publisher, Year.)**	-	-
1, 2, 3, 4, 5	Fundamentals of Electrical Drives, Gopal K. Dubey, Narosa Publishing House, 2nd Edition, 2001	1, 2,3,4,5, 6	In Lib / In Dept
5 14,15	Electrical Drives: Concepts and Applications (Refer to chapter 07 for Industrial Drives under module 5.), Vedum Subrahmanyam, McGraw Hill, 2nd Edition, 2011	2, 4	In Lib
B	**Reference books (Title, Authors, Edition, Publisher, Year.)**	-	-
5	Electric Drives, N.K De,P.K. Sen, PHI Learning, 1 st Edition, 2009	6	In Lib
	NPTEL VEDIOS		
C	**Concept Videos or Simulation for Understanding**	-	-
C1	Basics of electric drives https://www.youtube.com/watch?v=Ub-csHc4VhA 15 Mins		
C2	Speed torque characteristics and multi-quadrant operation, load equalization. https://www.youtube.com/watch?v=-L-weKRfDao: 28 mins https://www.youtube.com/watch?v=fn6dk508F1c: 58 mins		
C3	Selection of motor rating for electrical drives https://www.youtube.com/watch?v=hDQqcloXeA4: 44 mins		
C4	Nptel videos on DC motor electrical drives https://nptel.ac.in/courses/108105062/32; 54mins		
C5	Nptel videos on Induction motor electrical drives https://nptel.ac.in/courses/108105062/32		
C6	Nptel videos on Induction motor electrical drives https://www.youtube.com/watch?v=96hvtQ8Qlvo		
C7	Nptel vedios on Synchronous motor drives https://www.youtube.com/watch?v=b24jORRoxEc		

C8	Nptel vedios on Synchronous motor drives https://www.youtube.com/watch?v=E5CjfBRwoTo		
C9	Nptel vedios on Stepper motor drives https://nptel.ac.in/courses/108104011/30		
C10	Vedios on paper mill drive,traction drives https://www.youtube.com/watch?v=5RTuDefPHYE https://www.youtube.com/watch?v=r5noJwqB6Hw		
D	**Software Tools for Design**	**-**	**-**
	CAED tool for electrical drive design		
	National Instruments for circuit design		
E	**Recent Developments for Research**	**-**	**-**
	Industrial Automation https://ieeexplore.ieee.org/abstract/document/6891996		
F	**Others (Web, Video, Simulation, Notes etc.)**	**-**	**-**
1	https://nptel.ac.in/courses/108104011/40		

4. Course Prerequisites

Refer to GL01. If prerequisites are not taught earlier, GAP in curriculum needs to be addressed. Include in Remarks and implement in B.5.
Students must have learnt the following Courses / Topics with described Content . . .

Modules	Course Code	Course Name	Topic / Description	Sem	Remarks	Blooms Level
1	15ELN15	Basic Electronics	1. Knowledge on Basic working	2	-	L2
2	15EE53	Power Electronics	FET, MOSFET, BJT, IGBT Characteristics	3	-	L3
3	15EE44	Electric Motors	Knowledge DC Motor, Induction motors	4		L3

5. Content for Placement, Profession, HE and GATE

The content is not included in this course, but required to meet industry & profession requirements and help students for Placement, GATE, Higher Education, Entrepreneurship, etc. Identifying Area / Content requires experts consultation in the area.
Topics included are like, a. Advanced Topics, b. Recent Developments, c. Certificate Courses, d. Course Projects, e. New Software Tools, f. GATE Topics, g. NPTEL Videos, h. Swayam videos etc.

Modules	Topic / Description	Area	Remarks	Blooms Level
4	Synchronous machine models, transient and sub transient behavior.	Higher Study	Gap A seminar on Synchronous machine transient and sub - transient behavior.	Understand L2
5	Small machines used in drives for consumer goods	Higher Study	Gap A seminar on Small machines used in drives	Understand L2

B. OBE PARAMETERS

1. Course Outcomes

Expected learning outcomes of the course, which will be mapped to POs. Identify a max of 2 Concepts per Module. Write 1 CO per Concept.

Mod	Course	Course Outcome	Teach.	Concept	Instr	Assessme	Blooms'

ules	Code.#	**At the end of the course, student should be able to . . .**	Hours		Method	nt Method	Level
1	15EE82.1	Explain choice of electric drives by knowing its parts and advantages.	05	Choice of Electric drives	Lecture	Unit Test	L3 Apply
1	15EE82.2	Explain dynamics and different modes of operation of electric drives.	07	Dynamics of Electric drives	Lecture/ PPT	Assignme nt	L4 Analyze
2	15EE82.3	Selection of motor Power rating for a given electric drive application.	05	Selection of motor Power rating	Lecture	Assignme nt and unit Test	L3 Applying
2	15EE82.4	Control of DC motor using controlled rectifiers.	07	Control of DC motor Drives	Lecture / PPT	Assignme nt	L4 Analyze
3	15EE82.5	Operation of Induction motor with different conditions of source voltages.	05	Operation of Induction motor drives	Lecture	unit test	L3 Apply
3	15EE82.6	Analyze the performance of induction motor drives under different conditions.	06	Performan ce of Induction motor drives	Lecture and Tutorial	Assignme nt	L4 Analyze
4	15EE82.7	Control of induction motor using different type of Inverters.	05	Control of Induction motor drives	Lecture	Assignme nt and Unit Test	L3 Apply
4	15EE82.8	Analyze the performance of synchronous motor	06	Performan ce of Synchrono us motor	Lecture	Assignme nt	L4 Analyze
5	15EE82.9	Control of synchronous motor and Stepper motor drives under different conditions.	06	Control of synchrono us motor drives	Lecture / PPT	Assignme nt and Unit Test	L4 Analyze
5	15EE82.10	Propose a suitable electrical drive for specific application in the industry.	05	Industrial Application	Lecture	Assignme nt	L4 Analyze
-	**-**	**Total**	**57**	**-**	**-**	**-**	**L3-L4**

2. Course Applications

Write 1 or 2 applications per CO.
Students should be able to employ / apply the course learnings to . . .

Mod ules	Application Area Compiled from Module Applications.	CO	Level
1	Both AC and DC drives are used for the different operations in a cranes and hoists. The preferred drives on consideration of economy end utility	CO1	L4
2	DC motors are used for load hoisting and lowering where smooth, precise and at the same time fast speed control is required as in the case of cranes used in steel plants, power houses and concrete dams	CO3	L4

2	Permanent magnet DC motors are used extensively in small DC motors and to an increasing extent in traction applications.	CO3	L4
2	DC motors drives are inexpensive to manufacture and are used in variable speed household appliances such as sewing machines and power tools.	CO4	L4
3	Induction motors drives are mainly used in Compressors, conveyors and crushers widely use this type of motor.	CO5	L4
3	Normal starting current, high starting torque (double cage) squirrel cage motors with direct-on-line starters are used for conveyers drives because they have often to start with full load.	CO6	L3
4	The squirrel cage induction motors and synchronous motors are used for driving blowers and fans and compressors.	CO8	L3
4	Centrifugal pumps are driven by squirrel-cage induction motors or synchronous motors. Reduced voltage starters can be used because of low starting torque requirements	CO7	L4
5	Stepper motor drives are used in computer peripherals, textile industry, IC fabrications and robotics.	CO9	L4
5	Stepper motor drives are used in high speed pick and place equipment and multi axis machine, CNC machines etc.	CO9	L4
5	Industrial drives are used in textile industry, steel mills, paper mills and cement mills Machine tool applications, Coal mining, Centrifugal pumps and Turbo compressors etc.	CO10	L4

3. Mapping And Justification

CO – PO Mapping with mapping Level along with justification for each CO-PO pair.
To attain competency required (as defined in POs) in a specified area and the knowledge & ability required to accomplish it.

Modules	Mapping		Mapping Level	Justification for each CO-PO pair	Level
-	**CO**	**PO**	-	**'Area': 'Competency' and 'Knowledge' for specified 'Accomplishment'**	-
1	CO1	PO1	2.5	*Engineering Knowledge :* Knowledge of drives,motors is required to choice an electric drive.	L2
1	CO1	PO2	2.5	*Problem Analysis :*Identify the different parts of electric drives and its advantage to analyse the choice of electric drive.	L2
1	CO2	PO1	2.5	*Engineering Knowledge:* Knowledge of electric drives is required to know its dynamics	L2
1	CO2	PO2	2.5	*Problem Analysis:* Analyse the operation of electric drives in different modes of operations.	L3
1	CO2	PO3	2.5	*Design Solutions:* Analysing multi-quadrant operation and designing translational and rotational loads.	L3
2	CO3	PO1	2.5	Knowledge of different electric motors is required for selection of electric motor power rating.	L2
2	CO3	PO2	2.5	Analyses of electric drives for selection of electric motor power rating.	L3
2	CO4	PO1	2.5	Knowledge on DC motor and its types are required for Control of DC motor	L2
2	CO4	PO2	2.5	Analysis of DC motor using controlled rectifiers.	L3
2	CO4	PO3	2.5	Design of DC motor drives with different types of controlled rectifiers and choppers.	L4
3	CO5	PO1	2.5	Knowledge on induction motor and its types are required for Control of induction motor.	L2
3	CO5	PO2	2.5	Analysis of induction motor with different conditions of source voltages.	L3
3	CO6	PO1	2.5	Knowledge on induction motor and its control methods are required for Control of induction motor.	L2
3	CO6	PO2	2.5	Analyze the performance of induction motor drives under different conditions.	L3
3	CO6	PO3	2.5	Design of induction motor drives with different types of starting and braking systems.	L4
4	CO7	PO1	2.5	Knowledge on induction motor and its control methods are required for Control of induction motor.	L2

4	CO7	PO2	2.5	Analyse the different control techniques used in induction motor.	L3
4	CO7	PO3	2.5	Design of induction motor drives with different types of control techniques using inverters.	L4
4	CO8	PO1	2.5	Knowledge on synchronous motor and its types are required to analyse the performance.	L2
4	CO8	PO2	2.5	Analyze the performance of synchronous motor.	L3
5	CO9	PO1	2.5	Knowledge on synchronous motor and stepper motor and its control methods are required.	L2
5	CO9	PO2	2.5	Control of synchronous motor and Stepper motor drives under different conditions.	L3
5	CO9	PO3	2.5	Design of drives using different control techniques using cycloconverter and inverters.	L4
5	CO10	PO1	2.5	Knowledge on different electrical drives used in industry are required for a specific applications.	L2
5	CO10	PO2	2.5	Analysis of different electrical drives used in industry are required for a specific applications.	L3
5	CO10	PO9	2.5	Projects can be carried out using different control techniques in electrical drive system.	L3

4. Articulation Matrix

CO – PO Mapping with mapping level for each CO-PO pair, with course average attainment.

-	-	Course Outcomes	Program Outcomes														-
Modules	CO.#	**At the end of the course student should be able to . . .**	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	Level
1	15EE82.1	Explain choice of electric drives by knowing its parts and advantages.	2.5	2.5														L3
1	15EE82.2	Explain dynamics and different modes of operation of electric drives.	2.5	2.5	2.5													L4
2	15EE82.3	Selection of motor Power rating for a given electric drive application.	2.5	2.5														L3
2	15EE82.4	Control of DC motor using controlled rectifiers.	2.5	2.5														L4
3	15EE82.5	Operation of Induction motor with different conditions of source voltages.	2.5	2.5	2.5													L3
3	15EE82.6	Analyze the performance of induction motor drives under different conditions.	2.5	2.5	2.5													L4
4	15EE82.7	Control of induction motor using different type of Inverters.	2.5	2.5	2.5													L3
4	15EE82.8	Analyze the performance of synchronous motor	2.5	2.5														L4
5	15EE82.9	Control of synchronous motor and Stepper motor drives under different conditions.	2.5	2.5	2.5													L4
5	15EE82.10	Propose a suitable electrical drive for specific application in the industry.	2.5	2.5							2.5							L4
-	**EE82PC**	**Average attainment (1, 2, or 3)**																**-**
-	*PO, PSO*	*1.Engineering Knowledge; 2.Problem Analysis; 3.Design / Development of Solutions; 4.Conduct Investigations of Complex Problems; 5.Modern Tool Usage; 6.The Engineer and Society; 7.Environment and Sustainability; 8.Ethics; 9.Individual and Teamwork; 10.Communication; 11.Project Management and Finance; 12.Life-long Learning; S1.Software Engineering; S2.Data Base Management; S3.Web Design*																

5. Curricular Gap and Content

Topics & contents not covered (from A.4), but essential for the course to address POs and PSOs.

Modules	Gap Topic	Actions Planned	Schedule Planned	Resources Person	PO Mapping
1	Small machines used in drives	Seminar	2nd week / date	Dr XYZ, Inst	List from B4 above
2	A seminar on Synchronous machine transient and sub - transient behavior.	Seminar	3rd Week/	-	List from B4 above

6. Content Beyond Syllabus

Topics & contents required (from A.5) not addressed, but help students for Placement, GATE, Higher Education, Entrepreneurship, etc.

Modules	Gap Topic	Area	Actions Planned	Schedule Planned	Resources Person	PO Mapping
1	ANSYS HFSS - High Frequency Software Simulation Tool	Placement, GATE, Higher Study, Entrepreneurship.	Presentation by students & Mini Project	3rd week / date	Dr ABC, Inst. Self	List from B4 above
1	Antenna Fabrication process		Presentation	?	Self	
2						
2						
3						
3						
4						
4						
5						
5						

C. COURSE ASSESSMENT

1. Course Coverage

Assessment of learning outcomes for Internal and end semester evaluation. Distinct assignment for each student. 1 Assignment per chapter per student. 1 seminar per test per student.

Modules	Title	Teach. Hours	No. of question in Exam						CO	Levels
			CIA-1	CIA-2	CIA-3	Asg	Extra Asg	SEE		
1	Electrical Drives Dynamics of Electrical Drives Control Electrical Drives	12	2	-	-	1	1	2	CO1, CO2	L3, L4
2	Selection of Motor Power Ratings Direct Current Motor Drives	12	2	-	-	1	1	2	CO3, CO4	L3, L4
3	Induction Motor Drives	12	-	2	-	1	1	2	CO5, CO6	L3, L4
4	Induction Motor Drives (continued) Synchronous Motor Drives	11	-	2	-	1	1	2	CO7, C08	L3, L4
5	Synchronous Motor Drives (continued) Stepper Motor Drives Industrial Drives	11	-	-	4	1	1	2	CO9, CO10	L4, L4
-	**Total**	**58**	**4**	**4**	**4**	**5**	**5**	**10**	-	-

2. Continuous Internal Assessment (CIA)

Assessment of learning outcomes for Internal exams. Blooms Level in last column shall match with A.2.

Modules	Evaluation	Weightage in Marks	CO	Levels
1, 2	CIA Exam – 1	15	CO1, CO2, CO3, CO4	L3, L4, L3, L4
3, 4	CIA Exam – 2	15	CO5, CO6, CO7, C08	L3, L4, L3, L4
5	CIA Exam – 3	15	CO9, CO10	L4, L4
1, 2	Assignment - 1	05	CO1, CO2, CO3, CO4	L3, L4, L3, L4
3, 4	Assignment - 2	05	CO5, CO6, CO7, CO8	L3, L4, L3, L4
5	Assignment - 3	05	CO9, CO10	L4, L4
1, 2	Seminar - 1		-	-
3, 4	Seminar - 2		-	-
5	Seminar - 3		-	-
1, 2	Quiz - 1		-	-
3, 4	Quiz - 2		-	-
5	Quiz - 3		-	-
1 - 5	Other Activities – Mini Project	-	-	-
	Final CIA Marks	**20**	**-**	**-**

D1. TEACHING PLAN - 1

Module - 1

Title:	Microwave Tubes And Microwave Transmission Lines	Appr Time:	12 Hrs
a	***Course Outcomes***	**CO**	**Blooms**
-	At the end of the topic the student should be able to . . .	-	**Level**
1	Explain choice of electric drives by knowing its parts and advantages.	CO1	L3
2	Explain dynamics and different modes of operation of electric drives.	CO2	L4
b	***Course Schedule***	-	-
Class No	**Portion covered per hour**	**-**	**-**
1	**Electrical Drives**: Electrical Drives, Advantages of Electrical Drives.	C01	L3
2	Parts of Electrical Drives, Choice of Electrical Drives	C01	L2
3	Status of dc and ac Drives.	C01	L3
4	**Dynamics of Electrical Drives:** Fundamental Torque Equations.	C02	L4
5	Speed Torque Conventions and Multi quadrant Operation.	C02	L4
6	Equivalent Values of Drive Parameters	C02	L4
7	Components of Load Torques	C02	L4
8	Nature and Classification of Load Torques	C02	L4
9	Calculation of Time and Energy Loss in Transient Operations	C02	L3
10	Steady State Stability, Load Equalization	C02	L4
11	**Control Electrical Drives:** Modes of Operation, Speed Control and Drive Classifications	C02	L4
12	Closed loop Control of Drives.	C02	L4
c	**Application Areas**	**-**	**-**
-	Students should be able employ / apply the Module learnings to . . .	-	-
1	Both AC and DC drives are used for the different operations in a cranes and hoists. The preferred drives on consideration of economy end utility	CO1	L4
d	**Review Questions**	-	-
-	The attainment of the module learning assessed through following questions	-	-
1	With basic block diagram, explain the essential element of electric drive.	C01	L3
2	Explain the speed torque conventions and Multi quadrant Operation?	C02	L3
3	Derive the expression for the equivalent load torque and equivalent moment	C02	L3

	of inertia for loads with translational and rotational motion		
4	What are the advantages of an electric drive? Mention the factors on which the choice of electrical drive depends	C01	L3
5	Explain the components of load torque.		
6	What are load torque components? Define active and passive load torques.	CO2	L4
7	What is an electric drive? Mention the factors which decide the choice of electrical drive.	CO2	L4
8	What is load equalization? How it is achieved in industry	CO2	L4
9	Describe the steady state stability in the drive system. Derive the required condition for stability.	CO2	L4
e	**Experiences**	-	-
1		CO1	L2
2			

Module – 2

Title:	Microwave network theory and Microwave passive devices	Appr Time:	7 Hrs
a	***Course Outcomes***	**CO**	**Blooms**
-	At the end of the topic the student should be able to . . .	-	**Level**
1	Selection of motor Power rating for a given electric drive application.	CO3	L3
2	Control of DC motor using controlled rectifiers.	CO4	L4
b	***Course Schedule***	-	-
Class No	**Portion covered per hour**	**-**	**-**
13	**Selection of Motor Power Ratings:** Thermal Model of Motor for Heating and Cooling	CO3	L3
14	Classes of Motor Duty	CO3	L3
15	Determination of Motor Rating.	CO3	L3
16	**Direct Current Motor Drives:** Controlled Rectifier Fed dc Drives	CO4	L4
17	Single Phase Fully Controlled Rectifier Control of dc Separately Excited Motor	CO4	L4
18	Single Phase Half Controlled Rectifier Control of dc Separately Excited Motor	CO4	L4
19	Three Phase Fully Controlled Rectifier Control of dc Separately Excited Motor	CO4	L4
20	Three Phase Half Controlled Rectifier Control of dc Separately Excited Motor	CO4	L4
21	Multiquadrant Operation of dc Separately Excited Motor Fed Form Fully Controlled Rectifier	CO4	L4
22	Rectifier Control of dc Series Motor	CO4	L3
23	Supply Harmonics, Power Factor and Ripple in Motor Current	CO4	L3
24	Chopper Control of Separately Excited dc Motor, Chopper Control of Series Motor	CO4	L3
c	**Application Areas**	**-**	**-**
-	Students should be able employ / apply the Module learnings to . . .	-	-
1	DC motors are used for load hoisting and lowering where smooth, precise and at the same time fast speed control is required as in the case of cranes used in steel plants, power houses and concrete dams	CO3	L4
2	Permanent magnet DC motors are used extensively in small DC motors and to an increasing extent in traction applications.	CO3	L4
3	DC motors drives are inexpensive to manufacture and are used in variable speed household appliances such as sewing machines and power tools.	CO4	L4
d	**Review Questions**	-	-
-	The attainment of the module learning assessed through following questions	-	-
1	With usual notations, derive an expression for temperature rise of a machine. Sketch the temperature rise versus time curve.	CO3	L3

2	Derive an expression to obtain the power rating for short time duty loads.	CO3	L3
3	Obtain the thermal model of motor for heating and cooling. Also draw the heating and cooling.	CO3	L3
4	Derive the expression of overloading factor 'k' while selecting the main rating, for intermittent periodic duty.	C03	L3
5	Derive the expression to determine the power rating for continuous duty, fluctuating and intermittent loads by equivalent current, and torque and power methods.	CO3	L3
6	Explain the working of Single-phase half controlled rectifier for continuous mode of operation	CO4	L5
7	Explain the dynamic braking operation of separately excited dc motor. Draw its speed torque characteristics.	CO4	L2
8	With dynamic equivalent circuit, explain the transient analysis of separately excited dc motor.	CO4	L3
9	Explain the reverse voltage braking with diagrams of D.C of separately excited dc motor.	CO4	L3
10	Explain the plugging of D.C of separately excited dc motor and draw its speed torque characteristics.	CO4	L4
11	Explain the motoring control and regenerative braking of chopper control of separately excited dc motor.	CO4	L3
12	Explain the multi-quadrant operation of D.C of separately excited dc motor using Single-phase fully controlled rectifier with a reversing switch	CO4	L4
13	Explain the chopper control of separately excited dc motor for regenerative braking	CO4	L3
14	With a neat circuit diagram and waveform, explain the chopper control of series motor.	CO4	L4
15	Explain the dynamic braking of separately excited by chopper circuit.	CO4	L4
16	Explain the rectifier control of d.c series motor and draw its speed torque curve	CO4	L4
17	With circuit diagram and waveforms explain three phase fully controlled rectifier control of separately excited dc motor.	CO4	L4
e	**Experiences**	-	-
1		CO3	L2
2			

E1. CIA EXAM – 1

a. Model Question Paper - 1

Crs Code:	15EE82	Sem:8	I	Marks:	30	Time:	75 minutes
Course:	Industrial Drives and Applications						

-	-	**Note: Answer all questions, each carry equal marks. Module : 1, 2**	**Marks**	**CO**	**Level**
1	a	Obtain an expression for the equivalent load torque and equivalent moment of inertia for loads with translational motion and rotational motion.	20	CO2	L3
	b	With basic block diagram, Explain the essential parts of electric drive.		CO1	L2
	c	What are the advantages of an electric drive system? What is the status of ac and dc drives?		CO1	L2
		OR			
1	a	Explain the speed torque convention and four quadrant operation of a motor driving a hoist load.	20	CO2	L4
	b	With a neat graph, explain the various components of load torque		CO1	L4
	c	A motor is used to drive a hoist. Motor characteristics are given by Quadrant I, II and IV: T=200-0.2N, N-.m Quadrant II, III and IV: T=-200-0.2N, N-m Where N is the speed in rpm. When hoist is loaded, the net load torque Tl=100 N-m and when it is unloaded, net load torque Tl=-80, N-m. Obtain the equilibrium speeds for operation in all the four quadrants.		CO2	L3
	d	What is load equalization? How it is achieved in industry		CO2	L2

2	a	Derive an expression to obtain the power rating for short time duty loads.	20	CO3	L3
	b	With a neat diagram, explain the regenerative & dynamic braking.		CO4	L2
	c	Explain the working of Single-phase half controlled rectifier for continuous mode of operation		CO4	L2
		OR			
2	a	Obtain the thermal model of motor for heating and cooling. Also draw the heating and cooling.	20	CO3	L3
	b	With a neat circuit diagram and waveform, explain the chopper control of series motor.		CO4	L4
	c	With dynamic equivalent circuit, explain the transient analysis of separately excited dc motor.		CO4	L4

b. Assignment -1

Note: A distinct assignment to be assigned to each student.

Model Assignment Questions							
Crs Code:	15EE82	Sem:	8	Marks:	5 / 10	Time:	90 – 120 minutes
Course:	Industrial Drives and Applications						
Note: Each student to answer 2-3 assignments. Each assignment carries equal mark.							

SNo	USN	Assignment Description	Marks	CO	Level
1	1KT15EE007	With basic block diagram, explain the essential element of electric drive.	5	C01	L3
2	1KT15EE009	Explain the speed torque conventions and Multi quadrant Operation?	5	C02	L3
3	1KT15EE012	Derive the expression for the equivalent load torque and equivalent moment of inertia for loads with translational and rotational motion	5	C02	L3
4	1KT15EE014	What are the advantages of an electric drive? Mention the factors on which the choice of electrical drive depends	5	C01	L3
5	1KT15EE016	Explain the components of load torque.	5		
6	1KT15EE020	What are load torque components? Define active and passive load torques.	5	CO2	L4
7	1KT15EE021	What is an electric drive? Mention the factors which decide the choice of electrical drive.	5	CO2	L4
8	1KT14EE022	What is load equalization? How it is achieved in industry	5	CO2	L4
9	1KT14EE024	Describe the steady state stability in the drive system. Derive the required condition for stability.	5	CO2	L4
10	1KT14EE033	With usual notations, derive an expression for temperature rise of a machine. Sketch the temperature rise versus time curve.	5	CO3	L3
11	1KT16EE408	Derive an expression to obtain the power rating for short time duty loads.	5	CO3	L3
12	1KT16EE406	Obtain the thermal model of motor for heating and cooling. Also draw the heating and cooling.	5	CO3	L3
13	1KT16EE409	Derive the expression of overloading factor 'k' while selecting the main rating, for intermittent periodic duty.	5	C03	L3
14	1KT15EE007	Derive the expression to determine the power rating for continuous duty, fluctuating and intermittent loads by equivalent current, and torque and power methods.	5	CO3	L3
15	1KT15EE009	Explain the working of Single-phase half controlled rectifier for continuous mode of operation	5	CO4	L5
16	1KT15EE012	Explain the dynamic braking operation of separately excited dc motor. Draw its speed torque characteristics.	5	CO4	L2
17	1KT15EE014	With dynamic equivalent circuit, explain the transient analysis of separately excited dc motor.	5	CO4	L3
18	1KT15EE016	Explain the reverse voltage braking with diagrams of D.C of separately excited dc motor.	5	CO4	L3
19	1KT15EE020	Explain the plugging of D.C of separately excited dc motor and draw its speed torque characteristics.	5	CO4	L4
20	1KT15EE021	Explain the motoring control and regenerative braking of	5	CO4	L3

		chopper control of separately excited dc motor.			
21	1KT14EE022	Explain the multi-quadrant operation of D.C of separately excited dc motor using Single-phase fully controlled rectifier with a reversing switch	5	CO4	L4
22	1KT14EE024	Explain the chopper control of separately excited dc motor for regenerative braking	5	CO4	L3
23	1KT14EE033	With a neat circuit diagram and waveform, explain the chopper control of series motor.	5	CO4	L4
24	1KT16EE408	Explain the dynamic braking of separately excited by chopper circuit.	5	CO4	L4
25	1KT16EE406	Explain the rectifier control of d.c series motor and draw its speed torque curve	5	CO4	L4
26	1KT16EE409	With circuit diagram and waveforms explain three phase fully controlled rectifier control of separately excited dc motor.	5	CO4	L4

D2. TEACHING PLAN - 2

Module – 3

Title:	Striplines And Antenna Basics	Appr Time:	12 Hrs
a	***Course Outcomes***	**CO**	**Blooms**
-	At the end of the topic the student should be able to . . .	-	**Level**
1	Operation of Induction motor with different conditions of source voltages.	CO5	L3
2	Analyze the performance of induction motor drives under different conditions.	CO6	L4
b	***Course Schedule***		
Class No	**Portion covered per hour**	**-**	**-**
1	**Induction Motor Drives: Introduction**	CO5	L3
2	Analysis and Performance of Three Phase Induction Motors	CO5	L3
3	Operation with Unbalanced Source Voltage and Single Phasing	CO5	L3
4	Operation with Unbalanced Rotor Impedances	CO5	L3
5	Analysis of Induction Motor Fed From Non-Sinusoidal Voltage Supply	CO5	L3
6	Starting, Braking	CO6	L4
7	Transient Analysis	CO6	L4
8	Speed Control Techniques-Stator Voltage Control	CO6	L4
9	Problems	CO6	L4
10	Variable Voltage Frequency Control from Voltage Sources	CO6	L4
11	Problems	CO6	L4
12	Problems		
c	**Application Areas**	**-**	**-**
-	Students should be able employ / apply the Module learnings to . . .	-	-
1	Induction motors drives are mainly used in Compressors, conveyors and crushers widely use this type of motor.	CO5	L4
2	Normal starting current, high starting torque (double cage) squirrel cage motors with direct-on-line starters are used for conveyors drives because they have often to start with full load.	CO6	L3
d	**Review Questions**	-	-
-	The attainment of the module learning assessed through following questions	-	-
1	Explain the effect of unbalanced source voltage and single phasing on the Induction motor performance.	CO5	L3
2	Explain the effect of unbalanced rotor impedance on the Induction motor performance	CO5	L2
3	With neat diagrams, explain the a.c. dynamic braking with two-lead connection of a wound rotor induction motor.	CO6	L3
4	With circuit diagram and waveforms explain the operation of VSI fed IM drives. Also sketch various schemes of VSI fed IM	CO5	L2

5	With a neat drive circuit, explain the static scherbius drive	CO6	L3
6	With a neat block diagram, explain the closed loop speed control with regenerative braking of an Induction Motor	CO6	L3
7	What is slip-power recovery in an IM	CO6	L2
8	Explain the variable for control of an IM & draw the speed torque curves	CO6	L4
9	Describe the operation of 3-Φ induction motor operating with unbalanced source voltages & single phasing	CO5	L3
10	Explain the reverse voltage braking of an Induction motor	CO6	L3
11	Explain any 3 methods of starting of an Induction motor?	CO5	L4
12	A 400V, star connected, 3-Φ, 6 pole, 50Hz IM has the following parameters referred to the stator. Rs=Rr1=1Ω, Xs=Xr1=2Ω is to be braked by plugging from its initial full load speed of 950 rpm. Stator to rotor turns ratio is 2.3. (i) Calculate the initial braking current & torque as a ratio of their full load values. (ii) What resistance must be inserted in rotor circuit to reduce the maximum braking current to 1.5 times full load current? What will be initial braking torque now?	CO6	L3
13	A 2200V, 2600 KW, 735 rpm, 50Hz, 8 pole, 3-Φ squirrel cage induction motor has following parameters referred to the stator: Rs=0.075Ω, Rr1=0.1Ω, Xs=0.45Ω, Xr1=0.55Ω. Stator winding is delta connected & consist of 2 sections connected in parallel. Calculate starting torque & maximum torque as a ratio of rated torque, if the motor is started by star-delta switching. What is the maximum value of line current during starting?	CO6	L3
14	Explain the dynamic breaking and multiquadrant operation of voltage source inverter (VSI) induction motor drive.	CO6	L3
15	Explain plugging applied to a 3 -phase induction motor.	CO6	L2
e	**Experiences**	-	-
1		CO6	L2
2			

Module – 4

Title:	Antenna Point sources and Arrays And Electric DIpoles	Appr Time:	13 Hrs
a	***Course Outcomes***	**CO**	**Blooms**
-	At the end of the topic the student should be able to . . .	-	**Level**
1	Control of induction motor using different type of Inverters.	CO7	L3
2	Analyze the performance of synchronous motor	CO8	L4
b	***Course Schedule***		
Class No	**Portion covered per hour**	**-**	**-**
1	**Induction Motor Drives (continued)**	CO7	L3
2	Voltage Source Inverter (VSI) Control	CO7	L3
3	Cycloconverter Control	CO7	L3
4	Closed Loop Speed Control	CO7	L3
5	Converter Rating for VSI and Cycloconverter Induction Motor Drives	CO7	L3
6	Variable Frequency Control from a Current Source	CO7	L3
7	Current Source (CSI) Control	CO7	L3
8	current regulated voltage source inverter control, speed control of single phase induction motors	CO7	L3
9	**Synchronous Motor Drives: Introduction**	CO8	L4
10	Operation from fixed frequency supply-starting	CO8	L4
11	synchronous motor	CO8	L4
c	**Application Areas**	**-**	**-**
-	Students should be able employ / apply the Module learnings to . . .	-	-
1	The squirrel cage induction motors and synchronous motors are used for driving blowers and fans and compressors.	CO8	L3
2	Centrifugal pumps are driven by squirrel-cage induction motors or synchronous motors. Reduced voltage starters can be used because of low	CO7	L4

	starting torque requirements		
d	**Review Questions**	-	-
-	The attainment of the module learning assessed through following questions	-	-
1	Explain with diagram, the static rotor resistance control of an IM.	CO7	L2
2	What are the relative advantages and disadvantages of CSI & VSI drives?	CO7	L2
3	With a neat circuit diagram & waveforms, explain the operation of voltage source inverter fed IM drives	CO7	L3
4	Explain the operation of variable frequency control from voltage sources.	CO7	L3
5	Describe the speed control of 3-Φ induction motor by static rotor resistance control.	CO7	L4
6	Why the slip power recovery scheme is suitable mainly for drives with a low speed range?	CO7	L3
7	Explain static Kramer drive for slip recovery scheme.	CO7	L2
8	Describe the current source inverter control of induction motor	CO7	L3
9	Explain the dynamic breaking and multiquadrant operation of voltage source inverter(VSI) induction motor drive.	CO7	L3
10	With circuit diagram, explain the Self-controlled synchronous motor drive employing load commutated thyristor inverter.	CO8	L3
11	With block diagram, explain the operation of variable frequency control of multiple synchronous motor drive.	CO8	L3
12	Explain the pull-in process in the operation synchronous motor fed from fixed fr supply.	CO8	L4
13	Explain with block diagram, closed loop speed control of load commutated inverter synchronous motor drive.	CO8	L4
14	Explain the operation of synchronous motor from fixed frequency supply	CO8	L2
e	**Experiences**	-	-
1		CO7	L2
2			

E2. CIA EXAM – 2

a. Model Question Paper - 2

Crs Code:	15EE82	Sem: 8	II	Marks:	30	Time:	75 minutes
Course:	Industrial Drives and Applications						

-	-	**Note: Answer all questions, each carry equal marks. Module : 3, 4**	**Marks**	**CO**	**Level**
1	a	Explain the effect of unbalanced source voltage and single phasing on the Induction motor performance	20	CO5	L2
	b	Explain the variable for control of an IM & draw the speed torque curves		CO5	L3
	c	A 400V, star connected, 3-Φ, 6 pole, 50Hz IM has the following parameters referred to the stator. Rs=Rr1=1Ω, Xs=Xr1=2Ω is to be braked by plugging from its initial full load speed of 950 rpm. Stator to rotor turns ratio is 2.3. (i) Calculate the initial braking current & torque as a ratio of their full load values. (ii) What resistance must be inserted in rotor circuit to reduce the maximum braking current to 1.5 times full load current? What will be initial braking torque now?		CO6	L3
		OR			
1	a	With a neat block diagram, explain the closed loop speed control with regenerative braking of an Induction Motor	20	CO6	L3
	b	What is slip-power recovery in an IM		CO6	L2
	c	A 2200V, 2600 KW, 735 rpm, 50Hz, 8 pole, 3-Φ squirrel cage induction motor has following parameters referred to the stator: Rs=0.075Ω, Rr1=0.1Ω, Xs=0.45Ω, Xr1=0.55Ω. Stator winding is delta connected & consist of 2 sections connected in parallel. Calculate starting torque & maximum torque as a ratio of rated torque, if the motor is started by star-delta switching. What is the maximum value of line current during starting?		CO6	L3

2	a	With a neat circuit diagram & waveforms, explain the operation of voltage source inverter fed IM drives	20	CO7	L3
	b	Explain the pull-in process in the operation synchronous motor fed from fixed fr supply.		CO8	L4
	c	What are the relative advantages and disadvantages of CSI & VSI drives?		CO7	L2
		OR			
2	a	With circuit diagram, explain the Self-controlled synchronous motor drive employing load commutated thyristor inverter.	20	CO8	L3
	b	Describe the speed control of 3-Φ induction motor by static rotor resistance control.		CO7	L3
	c	Describe the current source inverter control of induction motor		CO7	L4

b. Assignment – 2

Note: A distinct assignment to be assigned to each student.

Model Assignment Questions							
Crs Code:	15EE82	Sem:	8	Marks:	5 / 10	Time:	90 – 120 minutes
Course:	Industrial Drives and Applications						
Note: Each student to answer 2-3 assignments. Each assignment carries equal mark.							

SNo	USN	Assignment Description	Marks	CO	Level
1	1KT15EE007	Explain the effect of unbalanced source voltage and single phasing on the Induction motor performance.	5	CO5	L3
2	1KT15EE009	Explain the effect of unbalanced rotor impedance on the Induction motor performance	**5**	CO5	L2
3	1KT15EE012	With neat diagrams, explain the a.c. dynamic braking with two-lead connection of a wound rotor induction motor.	**5**	CO6	L3
4	1KT15EE014	With circuit diagram and waveforms explain the operation of VSI fed IM drives. Also sketch various schemes of VSI fed IM	**5**	CO5	L2
5	1KT15EE016	With a neat drive circuit, explain the static scherbius drive	**5**	CO6	L3
6	1KT15EE020	With a neat block diagram, explain the closed loop speed control with regenerative braking of an Induction Motor	**5**	CO6	L3
7	1KT15EE021	What is slip-power recovery in an IM	**5**	CO6	L2
8	1KT14EE022	Explain the variable for control of an IM & draw the speed torque curves	**5**	CO6	L4
9	1KT14EE024	Describe the operation of 3-Φ induction motor operating with unbalanced source voltages & single phasing	**5**	CO5	L3
10	1KT14EE033	Explain the reverse voltage braking of an Induction motor	**5**	CO6	L3
11	1KT16EE408	Explain any 3 methods of starting of an Induction motor?	**5**	CO5	L4
12	1KT16EE406	A 400V, star connected, 3-Φ, 6 pole, 50Hz IM has the following parameters referred to the stator. Rs=Rr1=1Ω, Xs=Xr1=2Ω is to be braked by plugging from its initial full load speed of 950 rpm. Stator to rotor turns ratio is 2.3. (i) Calculate the initial braking current & torque as a ratio of their full load values. (ii) What resistance must be inserted in rotor circuit to reduce the maximum braking current to 1.5 times full load current? What will be initial braking torque now?	**5**	CO6	L3
13	1KT16EE409	A 2200V, 2600 KW, 735 rpm, 50Hz, 8 pole, 3-Φ squirrel cage induction motor has following parameters referred to the stator: Rs=0.075Ω, Rr1=0.1Ω, Xs=0.45Ω, Xr1=0.55Ω. Stator winding is delta connected & consist of 2 sections connected in parallel. Calculate starting torque & maximum torque as a ratio of rated torque, if the motor is started by star-delta switching. What is the maximum value of line current during starting?	**5**	CO6	L3
14	1KT15EE007	Explain the dynamic breaking and multiquadrant operation of voltage source inverter (VSI) induction motor drive.	**5**	CO6	L3
15	1KT15EE009	Explain plugging applied to a 3 -phase induction motor.	**5**	CO6	L2
16	1KT15EE012	Explain with diagram, the static rotor resistance control of an IM.	**5**	CO7	L2

17	1KT15EE014	What are the relative advantages and disadvantages of CSI & VSI drives?	**5**	CO7	L2
18	1KT15EE016	With a neat circuit diagram & waveforms, explain the operation of voltage source inverter fed IM drives	**5**	CO7	L3
19	1KT15EE020	Explain the operation of variable frequency control from voltage sources.	**5**	CO7	L3
20	1KT15EE021	Describe the speed control of 3-Φ induction motor by static rotor resistance control.	**5**	CO7	L4
21	1KT14EE022	Why the slip power recovery scheme is suitable mainly for drives with a low speed range?	**5**	CO7	L3
22	1KT14EE024	Explain static Kramer drive for slip recovery scheme.	**5**	CO7	L2
23	1KT14EE033	Describe the current source inverter control of induction motor	**5**	CO7	L3
24	1KT16EE408	Explain the dynamic breaking and multiquadrant operation of voltage source inverter(VSI) induction motor drive.	**5**	CO7	L3
25	1KT16EE406	With circuit diagram, explain the Self-controlled synchronous motor drive employing load commutated thyristor inverter.	**5**	CO8	L3
26	1KT16EE409	With block diagram, explain the operation of variable frequency control of multiple synchronous motor drive.	**5**	CO8	L3
27	1KT15EE007	Explain the pull-in process in the operation synchronous motor fed from fixed fr supply.	**5**	CO8	L4
28	1KT15EE009	Explain with block diagram, closed loop speed control of load commutated inverter synchronous motor drive.	**5**	CO8	L4
29	1KT15EE012	Explain the operation of synchronous motor from fixed frequency supply	**5**	CO8	L2
30	1KT15EE014	Explain with diagram, the static rotor resistance control of an IM.	**5**	CO7	L2

D3. TEACHING PLAN - 3

Module – 5

Title:	Loop and Horn Antenna and Antenna Types	Appr Time:	10 Hrs
a	***Course Outcomes***	**CO**	**Blooms**
-	At the end of the topic the student should be able to . . .	-	**Level**
1	Control of synchronous motor and Stepper motor drives under different conditions.	CO9	L4
2	Propose a suitable electrical drive for specific application in the industry.	CO10	L4
b	***Course Schedule***	-	-
Class No	**Portion covered per hour**	**-**	**-**
1	**Synchronous Motor Drives (continued)**	CO9	
2	Self-controlled synchronous motor drive employing load commutated thruster inverter	CO9	L4
3	Starting Large Synchronous Machines	CO9	L3
4	Permanent Magnet ac (PMAC) Motor Drives	CO9	L4
5	Sinusoidal PMAC Motor Drives	CO9	L3
6	Brushless dc Motor Drives	CO9	L3
7	**Stepper Motor Drives:** Variable Reluctance	CO10	L3
8	Permanent Magnet, Important Features of Stepper Motors, Torque Versus Stepping rate Characteristics	CO10	L3
9	Drive Circuits for Stepper Motor.	CO10	L4
10	**Industrial Drives:** Textile Mills, Steel Rolling Mills	CO10	L4
11	Cranes and Hoists, Machine Tools	CO10	L4
c	**Application Areas**	**-**	**-**
-	Students should be able employ / apply the Module learnings to . . .	-	-
1	Stepper motor drives are used in computer peripherals, textile industry, IC fabrications and robotics.	CO9	L4
2	Stepper motor drives are used in high speed pick and place equipment and	CO9	L4

	multi axis machine, CNC machines etc.		
3	Industrial drives are used in textile industry, steel mills, paper mills and cement mills Machine tool applications, Coal mining, Centrifugal pumps and Turbo compressors etc.	CO10	L4
d	**Review Questions**	-	-
-	The attainment of the module learning assessed through following questions	-	-
1	With block diagram, explain the operation of variable frequency control of multiple synchronous motor drive.	CO9	L3
2	Explain the pull-in process in the operation synchronous motor fed from fixed fr supply.	CO9	L2
3	Explain with block diagram, closed loop speed control of load commutated inverter synchronous motor drive.	CO9	L2
4	Explain the operation of synchronous motor from fixed frequency supply	CO9	L3
5	How the operation of a synchronous motor shifts from motoring to regenerative breaking	CO9	L3
6	Explain the modes of variable frequency control of synchronous motor	CO9	L3
7	With a neat diagram, explain the operation of a self controlled synchronous motor drive employing load commutated thyristor inverter.	CO9	L3
8	Explain variable frequency control of multiple synchronous motors.	CO9	L2
9	Obtain the dynamic torque equation for the synchronous motor drives and explain its regenerative braking.	CO9	L3
10	What are the important features of stepper motor?	CO10	L2
11	Explain with a neat graph Torque Versus Stepping rate Characteristics.	CO10	L3
12	With the help of neat diagram explain Drive Circuits for Stepper Motor	CO10	L3
13	Write a technical note on (i) Textile Mills (ii) Steel Rolling Mills	CO10	L2
14	Classify the drives used in cement industry and explain them.	CO10	L3
15	What are the requirements in steel mills? Explain with reasons motor used in steel mills.	CO10	L2
16	Explain the reversing and continuous rolling mill drives with selection of motors and their ratings	CO10	L3
17	Explain with neat dia, screw down operation in a rolling mill drive	CO10	L3
18	Explain the drives used in textile mill and explain briefly, any one of them.	CO10	L4
19	Explain clearly the driving motors used in the textile mill industry fir the different operations.	CO10	L4
20	What are the requirements in steel mills? Explain with reasons motor used in steel mills.	CO10	L4
e	**Experiences**	-	-
1		CO10	L2
2		CO9	

E3. CIA EXAM – 3

a. Model Question Paper - 3

Crs Code:	15EE82	Sem:	8	Marks:	30	Time:	75 minutes
Course:	Industrial Drives and Applications						

-	-	**Note: Answer all questions, each carry equal marks. Module : 5**	**Marks**	**CO**	**Level**
1	a	With block diagram, explain the operation of variable frequency control of multiple synchronous motor drive	20	CO9	L3
	b	Explain the modes of variable frequency control of synchronous motor		CO9	L3
	c	With a neat diagram, explain the operation of a self-controlled synchronous motor drive employing load commutated thyristor inverter.		CO9	L3
		OR			
2	a	Explain the pull-in process in the operation synchronous motor fed from fixed fr supply.	20	CO9	L4
	b	Explain variable frequency control of multiple synchronous motors.		CO9	L3

3	a	What are the important features of stepper motor?	20	CO10	L2
	b	Explain with a neat graph Torque Versus Stepping rate Characteristics.		CO10	L3
	c	What are the requirements in steel mills? Explain with reasons motor used in steel mills.		CO10	L3
		OR			
4	a	Explain clearly the driving motors used in the textile mill industry fir the different operations	20	Co10	L3
	b	Explain with neat dia, screw down operation in a rolling mill drive		CO10	L2
	c	Explain the drives used in textile mill and explain briefly, any one of them.		CO10	L3

b. Assignment – 3

Note: A distinct assignment to be assigned to each student.

Model Assignment Questions							
Crs Code:	15EE82	Sem:	8	Marks:	5 / 10	Time:	90 – 120 minutes
Course:	Industrial Drives and Applications						
Note: Each student to answer 2-3 assignments. Each assignment carries equal mark.							

SNo	USN	Assignment Description	Marks	CO	Level
1	1KT15EE007	Differentiate between VSI and CSI.	5	CO10	L3
2	1KT15EE009	Explain the modes of variable frequency control of synchronous motor	5	CO9	L3
3	1KT15EE012	With a neat diagram, explain the operation of a self controlled synchronous motor drive employing load commutated thyristor inverter.	5	CO9	L3
4	1KT15EE014	Explain variable frequency control of multiple synchronous motors.	5	CO9	L2
5	1KT15EE016	Obtain the dynamic torque equation for the synchronous motor drives and explain its regenerative braking.	5	CO9	L3
6	1KT15EE020	What are the important features of stepper motor?	5	CO10	L2
7	1KT15EE021	Explain with a neat graph Torque Versus Stepping rate Characteristics.	5	CO10	L3
8	1KT14EE022	With the help of neat diagram explain Drive Circuits for Stepper Motor	5	CO10	L3
9	1KT14EE024	Write a technical note on (i) Textile Mills (ii) Steel Rolling Mills	5	CO10	L2
10	1KT14EE033	Classify the drives used in cement industry and explain them.	5	CO10	L3
11	1KT16EE408	What are the requirements in steel mills? Explain with reasons motor used in steel mills.	5	CO10	L2
12	1KT16EE406	Explain the reversing and continuous rolling mill drives with selection of motors and their ratings	5	CO10	L3
13	1KT16EE409	Explain with neat dia, screw down operation in a rolling mill drive	5	CO10	L3
14	1KT15EE007	Explain the drives used in textile mill and explain briefly, any one of them.	5	CO10	L4
15	1KT15EE009	Explain clearly the driving motors used in the textile mill industry fir the different operations.	5	CO10	L4
16	1KT15EE012	With block diagram, explain the operation of variable frequency control of multiple synchronous motor drive.	5	CO9	L3
17	1KT15EE014	Explain the pull-in process in the operation synchronous motor fed from fixed fr supply.	5	CO9	L2
18	1KT15EE016	Explain with block diagram, closed loop speed control of load commutated inverter synchronous motor drive.	5	CO9	L2
19	1KT15EE020	Explain the operation of synchronous motor from fixed frequency supply	5	CO9	L3
20	1KT15EE021	How the operation of a synchronous motor shifts from motoring to regenerative breaking	5	CO9	L3

F. EXAM PREPARATION

1. University Model Question Paper

Course:		Industrial Drives and Applications						Month / Year		May /2018	
Crs Code:		15EE82	Sem:	8	Marks:	80		Time:80		180 minutes	
Module	**Note**	Answer all FIVE full questions. All questions carry equal marks.							**Marks**	**CO**	**Level**
1	a	Derive the expression for the equivalent load torque and equivalent moment of inertia for loads with translational and rotational motion							16 / 20	CO1	L3
	b	What are the advantages of an electric drive? Mention the factors on which the choice of electrical drive depends								CO1	L2
	c	What are load torque components? Define active and passive load torques.								CO1	L3
		OR									
-	a	What is an electric drive? Mention the factors which decide the choice of electrical drive.							16 / 20	CO1	L2
	b	What is load equalization? How it is achieved in industry								CO2	L2
	c	Describe the steady state stability in the drive system. Derive the required condition for stability.								CO2	L3
2	a	Derive the expression of overloading factor 'k' while selecting the main rating, for intermittent periodic duty.							16 / 20	CO3	L3
	b	Obtain the thermal model of motor for heating and cooling. Also draw the heating and cooling.								CO3	L4
	c	With a neat circuit diagram and waveform, explain the chopper control of series motor								CO4	L4
		OR									
-	a	Derive an expression to obtain the power rating for short time duty loads.							16 / 20	CO3	L3
	b	Explain the working of Single-phase half controlled rectifier for continuous mode of operation								CO4	L2
	c	Explain the dynamic braking operation of separately excited dc motor. Draw its speed torque characteristics.								CO4	L3
3	a	Explain the effect of unbalanced source voltage and single phasing on the Induction motor performance.							16 / 20	CO5	L3
	b	With a neat block diagram, explain the closed loop speed control with regenerative braking of an Induction Motor								CO6	L2
	c	A 400V, star connected, 3-Φ, 6 pole, 50Hz IM has the following parameters referred to the stator. Rs=Rr1=1Ω, Xs=Xr1=2Ω is to be braked by plugging from its initial full load speed of 950 rpm. Stator to rotor turns ratio is 2.3. (i) Calculate the initial braking current & torque as a ratio of their full load values. (ii) What resistance must be inserted in rotor circuit to reduce the maximum braking current to 1.5 times full load current? What will be initial braking torque now?								CO6	L3
		OR									
-	a	Explain plugging applied to a 3 -phase induction motor.							16 / 20	CO5	L2
	b	What is slip-power recovery in an IM								CO5	L2
	c	A 2200V, 2600 KW, 735 rpm, 50Hz, 8 pole, 3-Φ squirrel cage induction motor has following parameters referred to the stator: Rs=0.075Ω, Rr1=0.1Ω, Xs=0.45Ω, Xr1=0.55Ω. Stator winding is delta connected & consist of 2 sections connected in parallel. Calculate starting torque & maximum torque as a ratio of rated torque, if the motor is started by star-delta switching. What is the maximum value of line current during starting?								CO6	L3
4	a	With a neat circuit diagram & waveforms, explain the operation of voltage source inverter fed IM drives							16 / 20	CO7	L3
	b	Explain the operation of variable frequency control from voltage sources.								CO7	L3

	c	Explain with block diagram, closed loop speed control of load commutated inverter synchronous motor drive.		CO8	L2
		OR			
	a	Describe the speed control of 3-Φ induction motor by static rotor resistance control.	16 / 20	CO7	L2
	b	With block diagram, explain the operation of variable frequency control of multiple synchronous motor drive.		CO8	L3
	c	Explain the pull-in process in the operation synchronous motor fed from fixed fr supply.		CO8	L3
5	a	Explain clearly the driving motors used in the textile mill industry fir the different operations.	16 / 20	CO9	L4
	b	What are the important features of stepper motor?		CO10	L2
	c	Explain the modes of variable frequency control of synchronous motor		CO10	L3
		OR			
	a	What are the requirements in steel mills? Explain with reasons motor used in steel mills.	16 / 20	CO10	L4
	b	Explain with a neat graph Torque Versus Stepping rate Characteristics.		CO9	L3
	d	What are the differences between the Greedy and Dynamic programming methods of problem solving?			

2. SEE Important Questions

Course:	Industrial Drives and Applications					Month / Year	May /2018
Crs Code:	15EE82	Sem:	8	Marks:	100	Time:	180 minutes

	Note	Answer all FIVE full questions. All questions carry equal marks.	-	-	
Module	Qno.	Important Question	**Marks**	**CO**	**Year**
1	1	What is an electric drive? Mention the factors which decide the choice of electrical drive.	16 / 20	CO1	2014
	2	What is load equalization? How it is achieved in industry		CO1	2014
	3	Describe the steady state stability in the drive system. Derive the required condition for stability.		CO2	2017
	4	Derive the expression for the equivalent load torque and equivalent moment of inertia for loads with translational and rotational motion		CO2	2017
	5	What are the advantages of an electric drive? Mention the factors on which the choice of electrical drive depends		CO1	2015
2	1	Explain the working of Single-phase half controlled rectifier for continuous mode of operation	16 / 20	CO3	2015
	2	Explain the dynamic braking operation of separately excited dc motor. Draw its speed torque characteristics.		C04	2015
	3	Derive the expression of overloading factor 'k' while selecting the main rating, for intermittent periodic duty.		CO4	2009
	4	Obtain the thermal model of motor for heating and cooling. Also draw the heating and cooling.		CO3	2009
	5	With a neat circuit diagram and waveform, explain the chopper control of series motor		CO4	2014
3	1	Explain the effect of unbalanced source voltage and single phasing on the Induction motor performance.	16 / 20	CO5	2016
	2	With a neat block diagram, explain the closed loop speed control with regenerative braking of an Induction Motor		CO6	2016
	3	A 400V, star connected, 3-Φ, 6 pole, 50Hz IM has the following parameters referred to the stator. Rs=Rr1=1Ω, Xs=Xr1=2Ω is to be braked by plugging from its initial full load speed of 950 rpm. Stator to rotor turns ratio is 2.3. (i) Calculate the initial braking current & torque as a ratio of their full load values. (ii) What resistance must be inserted in rotor circuit		CO6	2017

		to reduce the maximum braking current to 1.5 times full load current? What will be initial braking torque now?			
	4	Explain plugging applied to a 3 -phase induction motor.		CO5	2014
	5	What is slip-power recovery in an IM		CO6	2014
4	1	With a neat circuit diagram & waveforms, explain the operation of voltage source inverter fed IM drives	16 / 20	CO7	2011
	2	Explain the operation of variable frequency control from voltage sources.		CO7	2012
	3	Explain with block diagram, closed loop speed control of load commutated inverter synchronous motor drive.		CO8	2016
	4	Describe the speed control of 3-Φ induction motor by static rotor resistance control.		CO7	2014
	5	With block diagram, explain the operation of variable frequency control of multiple synchronous motor drive.		CO8	2017
5	1	What are the requirements in steel mills? Explain with reasons motor used in steel mills.	16 / 20	CO10	2011
	2	Explain with a neat graph Torque Versus Stepping rate Characteristics.		CO10	2017
	3	Explain clearly the driving motors used in the textile mill industry fir the different operations.		CO10	2017
	4	What are the important features of stepper motor?		CO10	2014
	5	Explain the modes of variable frequency control of synchronous motor		CO9	2015

G. Content to Course Outcomes

1. TLPA Parameters

Table 1: TLPA – Example Course

Module-#	Course Content or Syllabus (Split module content into 2 parts which have similar concepts)	Content Teaching Hours	Blooms' Learning Levels for Content	Final Blooms' Level	Identified Action Verbs for Learning	Instruction Methods for Learning	Assessment Methods to Measure Learning
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*
1	**Electrical Drives**: Electrical Drives, Advantages of Electrical Drives. Parts of Electrical Drives, Choice of Electrical Drives, Status of dc and ac Drives.	05	- L1 - L2	L3	- Explain	Lecture	Unit Test
1	Dynamics of **Electrical Drives:** Fundamental Torque Equations, Speed Torque Conventions and Multi quadrant Operation. Equivalent Values of Drive Parameters, Components of Load Torques, Nature and Classification of Load Torques, Calculation of Time and Energy Loss in Transient Operations, Steady State Stability, Load Equalization. **Control Electrical Drives:** Modes of Operation, Speed Control and Drive Classifications, Closed loop Control of Drives.	07	- L1 - L2 - L3	L4	-Explain	Lecture/ PPT	Assignment
2	**Selection of Motor Power Ratings:** Thermal Model of Motor for Heating and Cooling, Classes of Motor Duty, Determination of Motor Rating.	05	- L2 - L3	L3	- Selection -Analyse	Lecture	Assignment and unit Test
2	**Direct Current Motor Drives:** Controlled Rectifier Fed dc Drives, Single Phase Fully Controlled Rectifier Control of dc Separately Excited Motor, Single Phase Half Controlled Rectifier Control of dc Separately Excited Motor, Three Phase Fully Controlled Rectifier Control of dc Separately Excited Motor, Three	7	- L2 - L3	L4	-Control	Lecture / PPT	Assignment

	Phase Half Controlled Rectifier Control of dc Separately Excited Motor, Multi quadrant Operation of dc Separately Excited Motor Fed Form Fully Controlled Rectifier ,Rectifier Control of dc Series Motor, Supply Harmonics, Power Factor and Ripple in Motor Current, Chopper Control of Separately Excited dc Motor, Chopper Control of Series Motor.						
3	**Induction Motor Drives:** Analysis and Performance of Three Phase Induction Motors, Operation with Unbalanced Source Voltage and Single Phasing, Operation with Unbalanced Rotor Impedances,	05	- L1 - L3 - L2	L3	-Operate	Lecture	unit test
3	Analysis of Induction Motor Fed From Non-Sinusoidal Voltage Supply, Starting, Braking, Transient Analysis. Speed Control Techniques-Stator Voltage Control, Variable Voltage Frequency Control from Voltage Sources.	06	- L3 - L2	L4	-- Analyse -	Lecture and Tutorial	Assignment
4	**Induction Motor Drives (continued):** Voltage Source Inverter (VSI) Control, Cycloconverter Control, Closed Loop Speed Control and Converter Rating for VSI and Cycloconverter Induction Motor Drives, Variable Frequency Control from a Current Source, Current Source (CSI) Control	05	- L3 - L1	L3	-Control -	Lecture	Assignment and Unit Test
4	Current regulated voltage source inverter control, speed control of single phase induction motors. **Synchronous Motor Drives:** Operation from fixed frequency supply-starting, synchronous motor.	06	- L3 - L4	L4	-Analyse -	Lecture	Assignment
5	**Synchronous Motor Drives (continued):** Self-controlled synchronous motor drive employing load commutated thruster inverter, Starting Large Synchronous Machines, Permanent Magnet ac (PMAC) Motor Drives, Sinusoidal PMAC Motor Drives, Brushless dc Motor Drives.	06	- L4 - L3	L4	-Control -	Lecture	Assignment and Unit Test
5	**Stepper Motor Drives:** Variable Reluctance, Permanent Magnet, Important Features of Stepper Motors, Torque Versus Stepping rate Characteristics, Drive Circuits for Stepper Motor. **Industrial Drives:** Textile Mills, Steel Rolling Mills, Cranes and Hoists, Machine Tools.	05	- L3 - L4	L4	-Analyse -Propose	Lecture	Assignment

2. Concepts and Outcomes:

Table 2: Concept to Outcome – Example Course

Module-#	Learning or Outcome from study of the Content or Syllabus	Identified Concepts from Content	Final Concept	Concept Justification (What all Learning Happened from the study of Content / Syllabus. A short word for learning or outcome)	CO Components (1.Action Verb, 2.Knowledge, 3.Condition / Methodology, 4.Benchmark)	Course Outcome **Student Should be able to ...**
A	*I*	*J*	*K*	*L*	*M*	*N*

1	- Study of basics of Electric drives - Advantages of Electric drives - Study of Dynamics of Electric drives	Choice of Electric drives	Choice	Choice of electric drives and its Status	- Explain -Basics of electric drives -knowing its parts	Explain choice of electric drives and its Dynamics by knowing its parts and advantages.
1	-Study of multi quadrant operation. -Study of Steady State Stability - Speed Control and Drive Classifications	- Dynamics of Electric drives -	Dynamics	Variation of torque and speed of an electric drive using multiquadrant operation.	- Explain -Dynamics of electric drives -Different quadrant of operation	Explain dynamics and Control of operation of electric drives.
2	-Study of thermal Model of Motor - Determination of Motor Rating	Selection of motor Power rating -	Motor Power Rating	Selection and Determination of Motor Rating.	-Selection -motor power rating -Drive applications	Selection of motor Power rating for a given electric drive application.
2	-Control of Rectifier Fed dc Drives - Control of Chopper Fed dc Drives -	-Control of DC motor Drives -	Control	Control of DC motor drives using controlled rectifiers and choppers	-Control -DC motor Controlled -rectifiers	Control of DC motor drives using controlled rectifiers.
3	- Performance of Three Phase Induction Motors - Operation with Unbalanced Source Voltage	- Operation of Induction motor drives	Operation	Operation of induction motor drives with Unbalanced Source Voltage.	-Operation -Induction motoring -source voltage	Operation of Induction motor with different conditions of source voltages.
3	- Analysis of Induction Motor Fed From Non-Sinusoidal Voltage Supply - Speed Control Techniques	Performance of Induction motor drives	Performance	Performance of induction motor drives by different control techniques	-Analyse -Performance of induction motoring -source voltage	Analyze the performance of induction motor drives under different conditions.
4	-Study of Inverter fed	Control of Induction	Control	Control of induction motor drives by	-Control -Induction motoring	Control of induction motor drives using

	Induction motor drives -Study of Cycloconverter fed Induction motor drives	motor drives		different control techniques	-Different types of inverters	different type of Inverters.
4	- Basics of synchronous motor drives. -Operation from fixed frequency supply.	Performance of Synchronous motor	Performance	performance of synchronous motor drives.	-Analyse -Performance of synchronous - Motoring	Analyze the performance of synchronous motor drives
5	-Study of Inverter fed synchronous motor drives. -Study of different types of AC motor drives	Control of synchronous motor drives	Control	Control of synchronous motor drives using inverters	-Control -Synchronous motor and Stepper motor drives -Different conditions.	Control of synchronous motor drives under different conditions.
5	- Features of Stepper Motors - Drive Circuits for Stepper Motor. - Study of some of the industrial drives	Stepper motor Control and Industrial Application	Industrial Applications	Study of some of the drives for industrial applications.	-Propose -Application in the industry. -Electrical drive	Propose a suitable electrical drive for specific application in the industry.