

Course Name: Electric Drives

Course Code: EE 701

Credit: 4

Prerequisites:

Sl. No.	Subject	Description	Level of Study
01	Electrical Machine	DC Motor, Induction Motor	4 th Sem, 5 th Sem
02	Power Electronics	Rectifier, Inverter(1-ph & 3ph)	6 th Sem

Course Objective:

- To expose students to the operation, application and control of power conversion systems employing electric drive to cater to industrial needs.
- To familiarize the operation principles, and design of starting, braking, and speed control arrangements for electric motors and their applications.
- To provide strong foundation to assess performance of different industrial drives considering issues such as, energy efficiency, power quality, economic justification, environmental issues, and practical viabilities.

Course Outcomes:

At the end of the course, a student will be able to:

1. **Examine** various applications in industrial and domestic areas where use of electric drives are essential.
2. **Classify** types of electric drives systems based on nature of loads, control objectives, performance and reliability.
3. **Combine** concepts of previously learnt courses such as, electrical machines, Control and power electronics to cater to the need of automations in industries.
4. **Select** most suitable type and specification of motor drive combination for efficient conversion and control of electric power.
5. **Identify** the critical areas in application levels, and **derive** typical solutions.
6. **Design and justify** new control and power conversion schemes for implementing alternative solutions considering the critical and contemporary issues.

CO- PO mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	2	1	2	1	-	-	-	2	1	1	1	3
2	1	1	2	2	-	-	-	-	1	1	1	-
3	1	2	2	1	1	-	-	-	1	1	1	1
4	-	1	1	2	1	-	-	2	1	1	1	1
5	1	1	2	2	-	-	-	-	1	1	1	3
6	1	2	2	1	-	2	1	1	1	1	1	3

Correlation levels 1, 2 or 3 as defined above: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) and “-” if there is no correlation.

Syllabus Indicating CO:

Module No.	Content	Relevant CO's
1	Electric Drive: Concept, classification, parts and advantages of electrical drives. Types of Loads, Components of load torques, Fundamental torque equations, Equivalent value of drive parameters for loads with rotational and translational motion. Determination of moment of inertia, Steady state stability, Transient stability. Multi-quadrant operation of drives. Load equalization.	CO1, CO 2 ,CO3 CO 4 ,CO5 ,CO 6
2	Motor power rating: Thermal model of motor for heating and cooling, classes of motor duty, determination of motor rating for continuous, short time and intermittent duty, equivalent current, torque and power methods of determination of rating for fluctuating and intermittent loads. Effect of load inertia & environmental factors.	CO1, CO 2 ,CO3 CO 4 ,CO5 ,CO 6
3	Starting of Electric Drives: Effect of starting on Power supply, motor and load. Methods of starting of electric motors. Acceleration time Energy relation during starting, methods to reduce the Energy loss during starting. Braking of Electric Drives: Types of braking, braking of DC motor, Induction motor and Synchronous motor, Energy loss during braking,	CO1, CO 2 ,CO3 CO 4 ,CO5 ,CO 6
4	DC motor drives: Modeling of DC motors, State space modeling, block diagram & Transfer function, Single phase, three phases fully controlled and half controlled DC drives. Dual converter control of DC drives. Power factor, supply harmonics and ripple in motor current chopper controlled DC motor drives.	CO1, CO 2 ,CO3 CO 4 ,CO5 ,CO 6
5	Induction motor drives: Stator voltage variation by three phase controllers, Speed control using chopper resistance in the rotor circuit, slip power recovery scheme. Pulse width modulated inverter fed and current source inverter fed induction motor drive. Volts/Hertz Control, Vector or Field oriented control.	CO1, CO 2 ,CO3 CO 4 ,CO5 ,CO 6
6	Synchronous motor drives: Variable frequency control, Self Control, Voltage source inverter fed synchronous motor drive, Vector control.	CO1, CO 2 ,CO3 CO 4 ,CO5 ,CO 6
7	Introduction to Solar and Battery Powered Drive, Stepper motor, Switched Reluctance motor drive Industrial application: Drive consideration for Textile mills, Steel rolling mills, Cement mills, Paper mills, Machine tools. Cranes & hoist drives.	CO1, CO 2 ,CO3 CO 4 ,CO5 ,CO 6

Gaps in Syllabus:

Sl. No.	Gap	Action taken	Relevance to POs
1	<p>Power Converter Design: <i>This is very useful to design electronic circuit for performances estimation, but missing in the syllabus.</i></p> <p>Topics covered: MATLAB Based power Converter is studied</p>	Additional lecture classes are organized to cover the topics	<p>PO 1, PO 2,PO3</p> <p>PO 4 ,PO7, PO8</p>
2	<p>Gate Driver Design: <i>This topic is very much relevant for manufacturing industries, but missing in the syllabus.</i></p> <p>Topics covered: Gate Pulse generation for control Switch.</p>	Additional lecture classes are organized to cover the topics	<p>PO 1, PO 2,PO3</p> <p>PO 5 ,PO7, PO8</p>
3	<p>Optical Isolation using semiconductor device: <i>This is an very important topic for isolating power circuit and control circuit, but missing in the syllabus.</i></p> <p>Topics covered: Photo Diode .Photo transistor etc</p>	Additional lecture classes are organized to cover the topics	<p>PO 1, PO 2,PO3</p> <p>PO 6 ,PO7, PO8</p>
4	<p>Linear Induction Motor Drive: <i>This is an very important topic but missing in the syllabus.</i></p> <p>Topics covered: Working Principal Torque Speed Characteristics suitable power converter</p>	Additional lecture classes are organized to cover the topics	<p>PO 1, PO 2,PO3</p> <p>Po 7, PO8</p>
5	<p>Switch Reluctance Motor Drive : <i>This is an important topic but missing in syllabus</i></p> <p>Topics covered: Working Principal Torque Speed Characteristics , suitable power converter</p>	Additional lecture classes are organized to cover the topics	<p>PO 1, PO 2</p> <p>PO 5 PO7, PO8</p>
6	<p>Brushless Dc motor Drive : <i>This is an important topic but missing in syllabus</i></p> <p>Topics Covered: Working Principal Torque Speed Characteristics , suitable power converter</p>	Additional lecture classes are organized to cover the topics	<p>PO 1, PO 2,PO3</p> <p>PO 4,PO7, PO8</p>

Lecture Plan:

Cl. No.	Date	Topics	Remarks
1		Electric Drive: Concept, classification, parts and advantages of electrical drives. Types of Loads, Components of load torques, Fundamental torque equations	
2		Equivalent value of drive parameters for loads with rotational and translational motion.	
3		Determination of moment of inertia, Steady state stability, Transient stability	
4		Multiquadrant operation of drives. Load equalization.	
5		Motor power rating: Thermal model of motor for heating and cooling, classes of motor duty	
6		determination of motor rating for continuous, short time and intermittent duty, equivalent current, torque and power	
7		methods of determination of rating for fluctuating and intermittent loads.	
8		Effect of load Inertia & environmental factors.	
9		Starting of Electric Drives: Effect of starting on Power supply, motor and load. Methods of starting of electric motors.	
10		Acceleration time Energy relation during starting, Methods to reduce the Energy loss during starting.	
11 & 12		Braking of Electric Drives: Types of braking, braking of DC motor	
13		Induction motor and Synchronous motor, Energy loss	

		during braking,	
14		DC motor drives: Modeling of DC motors, State space modeling, block diagram & Transfer function, Single phase, three phases fully controlled and half controlled DC drives.	
15 & 16		Dual converter control of DC drives. Power factor, supply harmonics and ripple in motor current chopper controlled DC motor drives.	
17 & 18		Induction motor drives: Stator voltage variation by three phase controllers, Speed control using chopper resistance in the rotor circuit,	
19 & 20		slip power recovery scheme Pulse width modulated inverter fed and current source inverter fed induction motor drive	
21		Volts/Hertz Control, Vector or Field oriented Control.	
22		Synchronous motor drives: Variable frequency control, Self Control, Voltage source inverter fed synchronous motor drive, Vector control.	
23 & 24		Introduction to Solar and Battery Powered Drive, Stepper motor, Switched Reluctance motor Drive	
25 & 26		Industrial application: Drive consideration for Textile mills, Steel rolling mills, Cement mills, Paper mills,	
27 & 28		Machine tools. Cranes & hoist drives.	

Recommended Books:

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1. Electric motor drives, R. Krishnan, PHI
2. Modern Power Electronics & Ac drives, B.K. Bose, Pearson Education.
3. Electric Motor & Drives. Austin Hughes, Newnes.

Numerical problems to be solved in tutorial classes.

Text Books:

1. Fundamental of Electrical Drives, G.K. Dubey, New Age International Publication.
2. Electric Drives, Vedam Subrahmanyam, TMH
3. A first course on Electrical Drives, S.K. Pillai, , New Age International Publication.