INDUSTRIAL DRIVES AND CONTROL **Course Code : 316330**

Programme Name/s : **Electrical Engineering/ Electrical Power System**
Programme Code : **EE/ EP**
Semester : **Sixth**
Course Title : **INDUSTRIAL DRIVES AND CONTROL**
Course Code : **316330**

I. RATIONALE

Industries are moving towards automation. The conventional speed control methods of motors are replaced by solid state drives which result in accurate, fast, precise speed, torque and power control to match the requirement of different type of loads. This course will enable the diploma students to develop cognitive, psychomotor and affective domain skill sets to control the speed and torque of a given motor and maintain the control circuits used in the field.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

The aim of this course is to help the student to attain the following industry-identified competency through various teaching-learning experiences ;

- **Control precisely the speed, torque and power of different motors to ensure optimal performance of industrial drive system.**

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Apply the basics of electric drive for precise motor control operation.
- CO2 - Use appropriate braking method for different AC and DC motors.
- CO3 - Control precisely the speed of a given DC motor using appropriate phase-controlled converter and chopper.
- CO4 - Control precisely the speed of a given Induction Motor using appropriate AC Drive technique.
- CO5 - Control precisely the speed of a given motor using advanced techniques.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme												
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TL				Based on SL		Total Marks
															Practical							
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
316330	INDUSTRIAL DRIVES AND CONTROL	IDC	DSE	3	-	2	1	6	3	3	30	70	100	40	25	10	25#	10	25	10	175

Total IKS Hrs for Sem. : 0 Hrs
Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment
Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination
Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 Describe the fundamental building blocks along with its function of typical electric drive. TLO 1.2 Classify Electric drives. TLO 1.3 Write the fundamental torque equation of motor load system specifying each parameter. TLO 1.4 Describe briefly four quadrant operation in an electric drive with neat labeled sketches. TLO 1.5 Classify the different components of load torque. TLO 1.6 Identify stable and unstable region of operation in speed-torque characteristics of a three-phase induction motor.	**Unit - I Basics of Electric Drives** 1.1 Electric Drive – Definition, block diagram and basic building blocks of an electric drive system. 1.2 Classification of Drives – AC, DC, Permanent Magnet Synchronous Motor (PMSM), Special motor drives. 1.3 Fundamental torque Equation 1.4 Multi-quadrant operation 1.5 Components of Load torque 1.6 Nature and classification of Load torque 1.7 Steady State Stability (No derivation)	Demonstration Lecture Using Chalk-Board Model Demonstration Video Demonstrations Flipped Classroom Presentations

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
2	TLO 2.1 Define braking. TLO 2.2 State different types of braking along with its advantages. TLO 2.3 Describe different braking methods used for DC series motor and DC shunt motor along with diagrams. TLO 2.4 Describe different braking methods used for three phase induction motors. TLO 2.5 Describe eddy current braking along with its applications.	**Unit - II Braking of Electric Motors** 2.1 Braking – Definition, types and advantages. 2.2 Braking of DC Series and DC Shunt Motor - Dynamic braking/Rheostatic braking , Regenerative braking and Plugging. 2.3 Braking of induction motor (Three Phase)- Rheostatic braking, Regenerative braking and Plugging. 2.4 Eddy current braking- Principle and application	Video Demonstrations Demonstration Flipped Classroom Lecture Using Chalk-Board Site/Industry Visit Presentations Model Demonstration
3	TLO 3.1 Describe a given type of single phase controlled converter fed separately excited DC motor drive with diagrams. TLO 3.2 Describe a given type of three phase controlled converter fed separately excited DC motor drive with diagrams. TLO 3.3 Describe basic chopper circuit. TLO 3.4 Classify choppers based on output voltage and quadrant operations. TLO 3.5 Describe the working of a given type of chopper based on quadrant operations. TLO 3.6 Describe the function of chopper controlled drives in solar and battery powered electric vehicles along with block diagrams.	**Unit - III DC Drives** 3.1 Single phase controlled converter fed separately excited DC motor drive 3.1.1 Single phase half wave converter drive. 3.1.2 Single phase semi converter drive. 3.1.3 Single phase full converter drive. 3.1.4 Single phase dual converter drive. 3.2 Three phase controlled converter fed separately excited DC motor drive 3.2.1 Three phase half wave converter drive. 3.2.2 Three phase semi converter drive. 3.2.3 Three phase full converter drive. 3.2.4 Three phase dual converter drive. 3.3 Basic chopper circuit using SCR. 3.4 Classification of chopper based on output voltage and quadrant operation. 3.5 Classification of chopper based on quadrant operation. 3.5.1 Class A Chopper Drive. 3.5.2 Class B Chopper Drive. 3.5.3 Class C Chopper Drive. 3.5.4 Class D Chopper Drive. 3.5.5 Class E Chopper Drive. 3.6 Application of chopper control drive in solar and battery powered electric vehicle (Block diagrams only)	Model Demonstration Video Demonstrations Demonstration Flipped Classroom Lecture Using Chalk-Board Site/Industry Visit

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
4	TLO 4.1 Explain the working of stator voltage control by using AC voltage controller. TLO 4.2 Describe the fundamental principle and working of Variable Frequency Drive (VFD). TLO 4.3 Describe variable frequency control of 3-phase induction motor using VSI. TLO 4.4 Describe sinusoidal PWM technique in AC drives. TLO 4.5 Describe variable frequency control of 3-phase induction motor using CSI. TLO 4.6 Describe given type of slip power recovery control of Three phase induction motor. TLO 4.7 Describe rotor resistance control for 3-phase slip ring induction motor. TLO 4.8 Explain the advantage of using soft starters for starting and speed control of induction motor.	**Unit - IV AC Drives** 4.1 Stator voltage control using AC voltage controller. 4.2 Variable Frequency Control (VFD). 4.3 Voltage Source Inverter Control. 4.4 AC drives using sinusoidal PWM technique. 4.5 Current Source Inverter Control. 4.6 Basics of Slip power recovery - static Kramer drive and static Scherbius drive. 4.7 Rotor Resistance Control. 4.8 Soft starters - Need, significance and working.	Demonstration Video Demonstrations Model Demonstration Flipped Classroom Site/Industry Visit Lecture Using Chalk-Board
5	TLO 5.1 State different types of servo motor along with its advantages. TLO 5.2 Describe with sketches the working of servo motor drives for given applications. TLO 5.3 Describe with sketches the working of BLDC motor drives. TLO 5.4 Describe the working of PLL in DC drive TLO 5.5 Describe the working of microcontroller controlled AC/DC drive. TLO 5.6 Describe the method to control step angle and speed of stepper motor using microcontroller. TLO 5.7 Describe the speed control of AC/DC motor drive using PLC.	**Unit - V Advanced Techniques for Motor Control** 5.1 Servo motor drive – introduction, working principle, types, advantages, disadvantages. 5.2 Applications of servo motor drive with block diagram:- Robotics, CNC machine. 5.3 BLDC motor drive - Introduction, Basic building block diagram, Application. 5.4 Phase Locked Loop (PLL) control for DC Motor. 5.5 AC/DC drive using microcontroller control. 5.6 Microcontroller based stepper motor control. 5.7 PLC controlled AC/DC motor drives.	Demonstration Lecture Using Chalk-Board Presentations Video Demonstrations Site/Industry Visit Model Demonstration

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

INDUSTRIAL DRIVES AND CONTROL **Course Code : 316330**

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Identify and explain the function of various parts of a DC drive system.	1	*Identification of various parts of DC drive.	2	CO1
LLO 2.1 Identify and explain the function of various parts of an AC drive system.	2	Identification of various parts of AC drive.	2	CO1
LLO 3.1 Control speed of DC shunt motor using single phase half wave-controlled converter. LLO 3.2 Plot torque speed characteristics of the DC shunt motor. LLO 3.3 Plot torque- current characteristics of the DC shunt motor.	3	*Speed control of DC shunt motor using single phase half wave-controlled converter.	2	CO3
LLO 4.1 Control speed of DC shunt motor using single phase full wave converter LLO 4.2 Plot torque speed characteristics of the DC shunt motor. LLO 4.3 Plot torque- current characteristics of the DC shunt motor.	4	*Speed control of DC shunt motor using single phase full wave converter.	2	CO3
LLO 5.1 Control speed of DC shunt motor using single phase semi converter. LLO 5.2 Plot torque speed characteristics of the DC shunt motor. LLO 5.3 Plot torque- current characteristics of the DC shunt motor.	5	Speed control of DC shunt motor using single phase semi converter.	2	CO3
LLO 6.1 Control the speed of DC shunt motor by armature voltage control method using step down chopper. LLO 6.2 Plot torque- current characteristics of the DC shunt motor. LLO 6.3 Plot torque- Speed characteristics of the DC shunt motor.	6	Speed control of DC Shunt motor by armature voltage control method using step down chopper.	2	CO3
LLO 7.1 Control speed of DC series motor by armature voltage control method using step down chopper. LLO 7.2 Plot torque speed characteristics of DC series motor. LLO 7.3 Plot torque current characteristics of DC series motor.	7	Speed control of DC series motor by armature voltage control method using step down chopper.	2	CO3
LLO 8.1 Control the speed of three phase squirrel cage induction motor by varying stator voltage using thyristor circuit. LLO 8.2 Plot torque speed characteristics of three phase squirrel cage induction motor.	8	Speed control of three phase squirrel cage induction motor using stator voltage control. (Thyristor circuit)	2	CO4

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 9.1 Speed control of three phase squirrel cage induction motor using Variable frequency Drive (VFD). LLO 9.2 Plot torque speed characteristics of three phase squirrel cage induction motor	9	*Speed control of three phase squirrel cage induction motor using VFD.	2	CO4
LLO 10.1 Control the speed of three phase slip ring induction motor using rotor resistance control method. LLO 10.2 Plot torque speed characteristics of three phase Slip ring induction motor.	10	*Speed control of three phase slip ring induction motor using rotor resistance control method.	2	CO4
LLO 11.1 Test the performance of v/f control based induction motor drive	11	*Soft start and control the speed of single/three phase induction motor by varying supply frequency using VSI and maintaining constant v/f ratio.	2	CO4
LLO 12.1 Identify parts of BLDC motor drive. LLO 12.2 Connect the parts of BLDC motor drive.	12	Connection of different parts of BLDC drive after identifying its different parts.	2	CO5
LLO 13.1 Control the speed of DC shunt motor using microcontroller. LLO 13.2 Plot torque speed characteristics of DC shunt motor LLO 13.3 Plot torque current characteristics of DC shunt motor	13	Speed control of DC shunt motor using microcontroller drive.	2	CO5
LLO 14.1 Control the speed of DC motor using Programmable Logic Controller(PLC).	14	*Speed control of DC motor using PLC.	2	CO5
LLO 15.1 Perform Plugging operation on given induction motor	15	* Perform Plugging operation on given induction motor	2	CO2

Note : Out of above suggestive LLOs -

- '*' Marked Practicals (LLOs) Are mandatory.
- Minimum 80% of above list of lab experiment are to be performed.
- Judicial mix of LLOs are to be performed to achieve desired outcomes.

VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)

Micro project

- Identify drive system in an amusement park and submit report on it.
- Build Step down chopper to control the speed of a small rating DC series motor.
- Build single phase full wave converters for speed control of a small rating DC shunt motor
- Design drive mechanism of a battery-operated bicycle of rating 24V/36V/48V, 250W/500/W/1000W using Brushless DC motor.
- Build Step down chopper to control the speed of 3 phase squirrel cage IM using Rotor Resistance control.
- Prepare a case study on energy efficient electric drive which uses DOL/ Star delta/ Auto transformer/soft starters

- Build a project to control the speed of existing motor in your lab using a Variable Frequency Drive.
- Design drive mechanism for stepper motor.
- Design a control system for a solar tracker that adjusts the position of solar panels to maximize energy harvesting throughout the day.
- Implement a system for controlling the position of a servo motor using a microcontroller.

Assignment

- Analyze factors affecting the efficiency of electric drive systems and propose methods to enhance performance, considering aspects like energy losses and thermal management.
- Examine the challenges and solutions associated with integrating electric drive systems with renewable energy sources such as wind turbines or solar panels
- Investigate the integration of chopper-controlled drives in solar and battery-powered electric vehicles and make report on it.
- Explain the basic principles of electric drives, including the relationship between torque, speed, and position in electric motors.
- Compare single-phase and three-phase converter configurations (half-wave, semi, full, and dual converters) in DC motor control.
- Explain how chopper-controlled drives facilitate regenerative braking in electric vehicles.

Visit

- Visit nearby market to carry out a Survey and submit a report on available choppers, inverters, dual converters for various drives used in our day-to-day life.
- Visit any one sugar/ paper/Steel/ textile mill or other to know the types of drives used in each stage of operation and submit a report on it.
- Visit nearby Industry having advanced technique for controlling speed of DC/AC motor. Prepare report of visit with special comments of AC/DC motor and semiconductor switches used.

Note :

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicial mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- For courses with no SLA component the list of suggestive microprojects / assignments/ activities are optional, faculty may encourage students to perform these tasks for enhanced learning experiences.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Microcontroller based trainer kit, Microcontroller based Embedded system, DC motor/three phase IM, LDR sensor, LED Series Interface	11,12
2	Open-Source software (MATLAB, SCILAB)	11,12
3	Brushless DC motor	12
4	PLC trainer kit	14

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
5	DC shunt motor (0.25HP to 1HP),	3,4,5,6,11
6	Dual channel CRO 25 MHZ with Isolation Transformer or power scope, attenuator probe for CRO	3,4,5,6,7,8
7	Experimental Thyristor trainer Kits Choppers, Inverters, Dual Converters, Induction heating, Dielectric heating and connecting cords.	3,4,5,6,7,8,1,2
8	Digital Multimeter 3 1/2-digit, 0-800 volts, 0-10 A, micro ammeter: 0-100 micro ampere	3,4,5,6,8,13,11,12
9	DC Series motor (0.25HP to 1HP),	7,1
10	Resistive load Lamp-100W, Heater Coil-500W	7,8
11	Three phase AC supply 440 V, 10A, 50 Hz	8,9,10,14,11
12	Three Phase Induction Motor (Squirrel Cage and Slip ring Induction Motor) (0.25HP to 1HP)	8,9,12,15
13	Variable frequency Drive (VFD) - 440V ,10A, PWM control Technique.	9
14	Single phase AC supply 230V, 10 A	All

IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Basics of Electric Drives	CO1	7	2	4	6	12
2	II	Braking of Electric Motors	CO2	6	2	4	4	10
3	III	DC Drives	CO3	13	4	6	10	20
4	IV	AC Drives	CO4	12	4	6	6	16
5	V	Advanced Techniques for Motor Control	CO5	7	2	4	6	12
Grand Total				**45**	**14**	**24**	**32**	**70**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- For formative assessment of theory, two offline unit tests of 30 marks are to be conducted and average of both unit test marks will be considered for out of 30 marks. For formative assessment of laboratory learning, 25 marks are to be considered. Each practical will be assessed considering 60% weightage to process and 40% weightage to product.

Summative Assessment (Assessment of Learning)

- For summative assessment of theory, End semester assessment of 70 marks. For summative assessment of laboratory learning, 25 marks are considered.

XI. SUGGESTED COS - POS MATRIX FORM

INDUSTRIAL DRIVES AND CONTROL **Course Code : 316330**

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO1	3	2	1	-	-	-	3			
CO2	3	2	1	1	-	-	3			
CO3	3	3	2	3	1	3	3			
CO4	3	3	2	3	-	2	3			
CO5	3	3	2	3	1	3	3			

Legends :- High:03, Medium:02,Low:01, No Mapping: -
*PSOs are to be formulated at institute level

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	G. K. Dubey	Fundamentals of Electrical Drives	Narosa Publishing House, ISBN: 978-81-7319-428-3
2	D. P. Kothari and Rakesh Singh Lodhi	Electric Drives	WILEY India Edition ISBN:978-9384588120
3	Srinivas Vemula and Ramaiah Veerlapati	Control of DC and AC Drives	Lap lambert academic publishing ISBN: 9783330053434
4	M.H. Rashid	Power Electronics devices circuits and applications	Pearson/Prentice Hall, 2004 ISBN:9780131011403
5	B. N. Sarkar	Fundamentals of Industrial Drive	PHI Learning Pvt. Ltd. ISBN:9788120344334
6	P.C SEN	Thyristor DC Drives	Wiley–Blackwell ISBN: 978-0471060703
7	P.S.Bimbhra	Power Electronics	Khanna Publishers ISBN:978-8174092793

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://nptel.ac.in/courses/108108077	Electric Drives
2	https://archive.nptel.ac.in/courses/108/104/108104140/	Fundamentals of Electric drives
3	http://www.ndl.gov.in/he_document/nptel/nptel/courses_108_104_108104140_video_lec16	Fundamentals of Electric drives
4	https://www.youtube.com/watch?v=pjwXSoOGXiE	Three phase fully controlled converter fed seperately excited DC motor
5	https://www.youtube.com/watch?v=VnAg5kfjFdo	Idea of VVVF Speed Control of Induction Motor
6	https://www.youtube.com/watch?v=dWQLNIbX8aM	Two quadrant chopper and Four Quadrant chopper for motor control

INDUSTRIAL DRIVES AND CONTROL **Course Code : 316330**

Sr.No	Link / Portal	Description
7	https://en.wikibooks.org/wiki/Power_Electronics	Solid state devices and soft starters.
8	https://www.youtube.com/watch?v=ww5uXJ38fqQ	Introduction to Speed Control

Note :

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students

MSBTE Approval Dt. 04/09/2025 **Semester - 6, K Scheme**