

INDUSTRIAL DRIVES**Course Code : 316341**

Programme Name/s : Industrial Electronics
Programme Code : IE
Semester : Sixth
Course Title : INDUSTRIAL DRIVES
Course Code : 316341

I. RATIONALE

Modern industries increasingly rely on automation, shifting from traditional motor speed control to precise, solid-state methods that regulate speed, torque, and power. This course aims to equip students with the necessary cognitive and psychomotor domain skills to effectively control motor speed and torque, and to confidently manage and maintain the control circuits essential to their work.

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 speed, torque and power of electric motors using solid state drives.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

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

- CO1 - Apply basics of electrical drive for selecting electric drive for given application.
- CO2 - Control precisely speed and torque of given DC motor using rectifier and chopper control DC drives.
- CO3 - Control precisely speed and torque of given induction motor using different AC drive techniques.
- CO4 - Control precisely speed and torque of PMSM and BLDC motors using solid state drives.
- CO5 - Control precisely speed, torque and position of servo motor using solid state drives.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme													Total Marks
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TL				Based on SL				
				CL	TL	LL					Practical												
											FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA				
													Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	
316341	INDUSTRIAL DRIVES	ADR	DSE	4	-	2	2	8	4	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

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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 function of each block of Electrical Drive. TLO 1.2 Classify Electrical drives. TLO 1.3 Select suitable Electrical Drive as per given requirement TLO 1.4 Interpret speed-torque characteristics to analyze motor performance under varying operating conditions	Unit - I Basics of Electrical Drives 1.1 General block diagram of Electrical Drives: Power Source, Electrical Motor, Power Modulator, Load, Sensing Unit, Control Unit, Advantages and Disadvantages of Electrical Drives. 1.2 Classification of Electrical Drives based on: Motors, Power supply, Power Electronic Converter, Number of Motors and load (Individual drive, Group Drive, Multi-motor Drive) 1.3 Selection criteria for electrical drives based on motor duty cycle: continuous duty, Fluctuating loads, short-term duty, and intermittent periodic duty 1.4 Fundamental Torque Equations, Speed Torque Conversions, Multi-quadrant Operation, and steady state stability	Lecture Using Chalk-Board Presentations Model Demonstration Video Demonstrations Flipped Classroom Hands-on Site/Industry Visit Collaborative learning
2	TLO 2.1 Compare the performance of DC shunt and series motors. TLO 2.2 Describe a suitable speed control technique of DC motor for given requirement. TLO 2.3 Describe a suitable braking technique of DC shunt motor for given requirement. TLO 2.4 Describe a suitable phase control rectifier for speed control of DC shunt motor for given requirement. TLO 2.5 Describe a suitable chopper for speed control of DC shunt motor for given requirement.	Unit - II DC Drives 2.1 DC shunt and series motor characteristics: Torque-speed, armature current-speed, and torque-armature current characteristics with related equations. 2.2 Speed control techniques of DC shunt and DC series motors: armature voltage control and field flux control. 2.3 Braking techniques of DC motor: Dynamic braking, Plugging, Regenerative braking 2.4 Speed control of DC shunt motor using phase controlled rectifiers with circuit diagram, working and waveforms: Single phase half wave controlled rectifier with and without freewheeling diode, Single phase full wave controlled rectifier with and without freewheeling diode, Single phase semi-converter, Three-phase full controlled rectifier. 2.5 Speed control of DC shunt motor with circuit diagram, working and waveforms: Type A chopper, Type B Chopper, Type C Chopper, Type D Chopper, Type E Chopper.	Lecture Using Chalk-Board Presentations Video Demonstrations Flipped Classroom Hands-on Site/Industry Visit Model Demonstration Collaborative learning
3	TLO 3.1 Identify a suitable induction motor for given type of load. TLO 3.2 Describe a suitable speed control techniques of induction motor for given requirements. TLO 3.3 Describe a suitable braking technique for induction motor for given requirement. TLO 3.4 Use different types of converter for controlling speed of induction motor.	Unit - III AC Drives 3.1 AC motor: Overview, construction and working, Classification, Torque-speed/slip characteristics 3.2 Speed control techniques for induction motors: voltage control, frequency control and V/f control 3.3 Braking techniques of induction motor: Plugging or phase sequence changing, regenerative braking 3.4 Soft starting and speed control of induction motor with circuit diagram, working and waveforms: AC Voltage control using TRIAC and VSI, Frequency control using VSI, V/f control using VSI.	Lecture Using Chalk-Board Presentations Video Demonstrations Model Demonstration Flipped Classroom Hands-on Collaborative learning Site/Industry Visit
4	TLO 4.1 Summarize the construction and torque production mechanism of PMSM motors to determine their suitability for specific applications	Unit - IV PMSM and BLDC drives 4.1 Introduction to PMSM: Construction, types, working principle, Torque- speed characteristics, Advantages, Disadvantages 4.2 Introduction to BLDC Motors: Construction, types, working principle, Torque- speed characteristics,	Lecture Using Chalk-Board Presentations Video Demonstrations Model

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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.
	TLO 4.2 Summarize the construction and torque production mechanism of BLDC motors to determine their suitability for specific applications TLO 4.3 Describe a suitable electronic commutator for BLDC motor. TLO 4.4 Describe the working principle of scalar control (V/f) for PMSM speed control using a block diagram.	Advantages, Disadvantages. 4.3 Electronic commutation for BLDC motors: Requirement and working of unipolar and bipolar drive with circuit diagram and waveform 4.4 Speed control technique for PMSM: Scalar control working with block diagram.	Demonstration Flipped Classroom Hands-on Collaborative learning Site/Industry Visit
5	TLO 5.1 Summarize the key factors that influence the suitability of different servo motor TLO 5.2 Compare given strategies for controlling of servo motor. TLO 5.3 Describe a suitable drive for given servo motor. TLO 5.4 Describe with sketches the working of servo motor drives for given applications.	Unit - V Servo Motor Drives 5.1 Introduction to Servo Motor: Construction, types, working principle, Application, Advantages, Disadvantages. 5.2 Control strategy for servo motors: Position control, Speed Control and Torque control. 5.3 Servo drives working: H-Bridge Configurations for DC Servo Motors, Three-Phase Inverter Topologies for AC Servo Motors 5.4 Specific applications of servo motors in: Robotics, CNC machine, Medical Equipment, 3D Printers (Block diagram and working).	Lecture Using Chalk-Board Presentations Video Demonstrations Model Demonstration Flipped Classroom Hands-on Site/Industry Visit Collaborative learning

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

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Identify suitable parts of the motor drive LLO 1.2 Connect the different parts of the motor drive for effective operation	1	*Identification and connection of different parts of the motor drive	2	CO1
LLO 2.1 Test the performance of single phase full wave controlled rectifier based DC drive	2	*Speed control of DC shunt motor using a single phase full wave controlled rectifier	2	CO2
LLO 3.1 Test the performance of single phase semi-converter based DC drive	3	Speed control of DC shunt motor using a single phase semi-converter	2	CO2
LLO 4.1 Test the performance of step down chopper based DC drive	4	*Speed control of DC shunt motor using a step down chopper.	2	CO2
LLO 5.1 Test the performance of step up chopper based DC drive	5	Speed control of DC shunt motor using a step-up chopper.	2	CO2
LLO 6.1 Test the performance of TRIAC based Induction motor drive.	6	*Soft starting and speed control of a single/three phase induction motor by varying AC voltage using TRIAC	2	CO3
LLO 7.1 Test the performance of frequency control based Induction motor drive.	7	Soft starting and speed control of a single/three phase induction motor by varying the supply frequency using VSI.	2	CO3

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Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 8.1 Test the performance of V/f control based Induction motor drive.	8	*Soft starting and speed control of a single/three phase induction motor by varying the supply frequency using VSI and maintaining constant V/f ratio.	2	CO3
LLO 9.1 Identify different parts of the BLDC motor drive LLO 9.2 Connect different parts of the BLDC motor drive for effective operation	9	Identification and connection of different parts of the BLDC motor drive	2	CO4
LLO 10.1 Identify different parts of the PMSM motor drive LLO 10.2 Connect different parts of the PMSM motor drive for effective operation	10	Identification and connection of different parts of the PMSM motor drive	2	CO4
LLO 11.1 Test the performance of BLDC motor drive based on unipolar drive	11	*Soft starting and speed control of a BLDC motor using unipolar drive	2	CO4
LLO 12.1 Test the performance of BLDC motor drive based on bipolar drive	12	Soft starting and speed control of a BLDC motor using bipolar drive	2	CO4
LLO 13.1 Identify different parts of the DC servo motor drive LLO 13.2 Connect different parts of the DC servo motor drive for effective operation	13	Identification and connection of different parts of the DC servo motor drive	2	CO5
LLO 14.1 Identify different parts of the AC servo motor drive LLO 14.2 Connect different parts of the AC servo motor drive	14	Identification and connection of different parts of the AC servo motor drive	2	CO5
LLO 15.1 Test the performance of DC servo motor drive	15	*Angular position control of DC servo motor using PWM based drive	2	CO5
LLO 16.1 Test the performance of AC servo motor drive	16	Angular position control of AC servo motor using PWM based drive	2	CO5
LLO 17.1 Test the performance of step up chopper based DC drive LLO 17.2 Test the performance of DC/AC servo motor drive	17	Speed control of DC/AC servo motor with PWM based drive.	2	CO5
LLO 18.1 Test the performance of electric drive with relevant sensor	18	*Interfacing electric drive with relevant sensor	2	CO5

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)**Assignment**

- Visit the paper mill to identify the types of drives used in each stage of operation and report.
- Visit the rolling mill to identify the types of drives used in each stage of operation and report.
- Perform an industry survey on types of motor based on duty cycle available in the market and prepare a report

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- Visit the textile mill to identify the types of drives used in each stage of operation and report.
- Visit the sugar mill to identify the types of drives used in each stage of operation and report.
- Visit the elevator and escalator to identify the types of drives used in each stage of operation and report.

Micro project

- Test the performance of the Servo motor drive using simulation and prepare a report on it
- Test the performance of AC motor drive using simulation and prepare a report on it
- Test the performance of DC motor drive using simulation and prepare a report on it
- Test the performance of BLDC motor drive using simulation and prepare a report on it
- Test the performance of PMSM drive using simulation and prepare a report on it

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 judicious 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	Three-phase PMSM motor drive 3 kW, 3000 RPM, 380-415 V AC, 100 Hz, 35 Nm,	10
2	DC servo motor drive 200W, 24V DC, 1.27 Nm, 1500 RPM,	13,15,17
3	AC servo motor drive 400 W, 3000 RPM, 1.27 Nm, 220V AC	14,16,17
4	DC shunt motor drive 1 Hp, 220V, 1500 RPM	4,5,2,3
5	DC Ammeter 0-1/2 A, 0-5/10 A	4,5,2,3,13
6	DC Voltmeter 0-150/300	4,5,2,3,13
7	CRO : Dual Channel, 4 Trace CRT / TFT based Bandwidth 20 MHz/30 Mhz X10 magnification 20 nS max sweep rate, Alternate triggering, Component tester and with optional features such as Digital Read out with USB interface	4,5,2,3,6,7,8,11,12,15,16
8	MATLAB / SCILAB / PSIM, Proteus, Multisim software	4,5,2,3,6,7,8,11,12,15,16
9	Contact/ Non Contact type Tachometer 10000 RPM	4,5,2,3,6,7,8,11,12,15,16
10	Single / three phase induction motor 1/5 Hp, 230V, 415 V, 50 Hz, Slipring / Squirrel cage, 1450 RPM	6,7,8
11	AC Voltmeter 0-150/300 V, 0-500 V	6,7,8,11,12,14,16
12	AC Ammeter 0-5/10 A	6,7,8,11,12,14,16
13	Dimmer Single phase 0-270 V, 1/5 kVA, 50 Hz	6,7,8,14,16
14	Dimmer three phase 0-415 V, 10 kVA, 50 Hz	6,7,8,14,16
15	BLDC motor drive 2 kW, 3000 RPM, 6.45 Nm, 48V, 60V, 72V DC, external control with sensor/sensor-less commutation,	9,11,12
16	Multimeter : 2000 count digital display , 1000V DC / 750 V AC ranges, 10A AC/DC range	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 Electrical Drives	CO1	9	6	4	0	10

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Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
2	II	DC Drives	CO2	14	2	4	10	16
3	III	AC Drives	CO3	14	6	4	6	16
4	IV	PMSM and BLDC drives	CO4	14	6	6	4	16
5	V	Servo Motor Drives	CO5	9	2	4	6	12
Grand Total				60	22	22	26	70

X. ASSESSMENT METHODOLOGIES/TOOLS**Formative assessment (Assessment for Learning)**

• Two offline unit tests of 30 marks and average of two unit test marks will be consider for out of 30 marks. For formative assessment of laboratory learning 25 marks Each practical will be assessed considering 60% weightage to process, 40% weightage to product.

Summative Assessment (Assessment of Learning)

• End semester assessment of 70 marks. End semester summative assessment of 25 marks for laboratory learning.

XI. SUGGESTED COS - POS MATRIX FORM

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	1	1	1	-	-	1			
CO2	2	2	2	3	1	-	2			
CO3	2	2	2	3	1	-	2			
CO4	2	2	2	3	1	-	2			
CO5	2	2	2	3	1	-	2			
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, ISBN10: 1842650831
2	P. S. Bhimbhra	Power Electronics	Khanna Publishing, ISBN-10: 8195123120
3	G. K. Dubey	Power semiconductor controlled Drives	Prentice Hall international, New Jersey, ISBN-10: 0136868908
4	M Singh and K. Khanchandani	Power Electronics	McGraw Hill Education, ISBN-10: 0070583897
5	R. Krishnan	Electric Motor Drives: Modelling Analysis and Control	Pearson Education India, ISBN-10: 9789332549715
6	Muhammad H. Rashid	Power Electronics: Devices, Circuits, and Applications	Pearson Education, ISBN-10: 9332584583

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
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Sr.No	Link / Portal	Description
1	https://www.scilab.org/software/xcos/simulation	Sci Lab
2	https://archive.nptel.ac.in/courses/108/104/108104140/	Fundamentals of Electrical Drives, NPTEL
3	https://archive.nptel.ac.in/courses/108/102/108102046/	Introduction to Electrical Drives, NPTEL

Note :

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

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