COURSE TITLE	**POWER ELECTRONIC CONVERTERS & DRIVES**
COURSE CODE	**01EC0315**
COURSE CREDITS	**4**

Objective:

1 This course aims to provide knowledge of power electronic converters and their role in electric drive systems. It covers phase controlled converters, DC-DC converters, and inverters, along with their applications in DC and AC motor drives, including speed control, braking methods, performance characteristics, and closed loop control of electrical drives.

Course Outcomes: After completion of this course, student will be able to:

1 Describe and interpret single phase and three phase phase-controlled converters, input power factor, harmonic factor, dual converters, and power factor improvement techniques

2 Outline and relate DC-DC converters and choppers with DC motor drives including four quadrant operation, dynamic braking, and regenerative braking

3 Explain and differentiate single phase and three phase inverters, PWM techniques, and multilevel inverter configurations

4 Discuss induction motor drives and synchronous motor drives including speed control methods, slip power recovery schemes, and closed loop control of DC and AC drives

Pre-requisite of course: Basic knowledge of Analog Circuits, Semiconductor devices and switching characteristics

Teaching and Examination Scheme

Theory Hours	Tutorial Hours	Practical Hours	ESE	IA	CSE	Viva	Term Work
3	0	2	50	30	20	25	25

Contents : Unit	Topics	Contact Hours
1	**Phase controlled converters** Introduction to Phase Controlled Converters, Single-Phase Half Controlled Converters, Single-Phase Fully Controlled Converters, Input Power Factor and Harmonic Analysis – Evaluation of power factor and harmonic factor, Single-Phase Dual Converters and Power Factor Improvement Techniques, Three-Phase Half Controlled Converters, Three-Phase Fully Controlled Converters, Effect of Input Line Inductance and Advanced Converter Configurations – 12-pulse and 18-pulse converters, Dual Converters, Front-End Converters, and Synchronous Link Converters, Basic Power Electronic Drive System – Components and types of loads, Shaft-Load Coupling and Stability of Power Electronic Drives, Converter-Fed DC Motor Drives – Torque-speed characteristics, continuous and discontinuous conduction modes	12

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Contents : Unit	Topics	Contact Hours
2	**DC-DC converters** Introduction to Choppers and Their Classification, Class A and Class B Choppers, Class C and Class D Choppers, Operation and Control Techniques of Choppers, Non-Isolated DC–DC Converters – Buck, Boost, and Buck–Boost Converters, Isolated DC–DC Converters – Flyback and Forward Converters, DC Motor Drives Using DC–DC Converters – Separately excited motor, Four-Quadrant Operation of DC Drives, Dynamic Braking in DC Drives, Regenerative Braking in DC Drives	10
3	**Inverters** Introduction to Inverters and Single-Phase Inverters, Voltage Source Inverter (VSI), Current Source Inverter (CSI), Three-Phase Inverters – Basic Operation, Conduction Modes – 120° and 180° conduction, Output Voltage Analysis of Inverters, Pulse Width Modulation (PWM) Techniques – Overview, PWM Methods – Single Pulse, Multiple Pulse, and Sinusoidal PWM, Advanced PWM Techniques – Space Vector PWM, Multilevel Inverters – Diode Clamped, Flying Capacitor, and Cascaded H-Bridge	10
4	**Induction and synchronous motor drives** Induction Motor Equivalent Circuit, Speed Control Methods of Induction Motors – Overview, Stator Voltage Control Method, Rotor Resistance Control Method, Frequency Control (V/f Control) of Induction Motors, Slip Power Recovery Schemes, Synchronous Motor Drives – Operation with fixed and variable frequency supply, Closed-Loop Control of Drives – Fundamentals, Closed-Loop Control of DC Drives, Closed-Loop Control of AC Drives	10
Total Hours		**42**

Suggested List of Experiments:

Contents : Unit	Topics	Contact Hours
1	**Experiment No 1** To study the operation of a single phase half controlled converter and determine the variation of average output voltage with firing angle for a given R load.	2
2	**Experiment No 2** To study the operation of a single phase fully controlled converter and determine the variation of output voltage with firing angle for R and RL loads.	2
3	**Experiment No 3** To measure the input power factor and analyze harmonic content of a single phase controlled converter for different firing angles.	2
4	**Experiment No 4** To study the operation of a single phase dual converter and observe forward and reverse modes of operation.	2

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Suggested List of Experiments:

Contents : Unit	Topics	Contact Hours
5	**Experiment No 5** To study the operation of a three phase fully controlled converter and determine the output voltage characteristics for different firing angles.	2
6	**Experiment No 6** To study the effect of source inductance on the performance of a converter and observe overlap angle and output voltage reduction.	2
7	**Experiment No 7** To study the operation of a Class A chopper and determine the relationship between duty cycle and output voltage.	2
8	**Experiment No 8** To study the operation of a Class B chopper and observe regenerative mode of operation.	2
9	**Experiment No 9** To study the operation of a Class C chopper and analyze two quadrant operation.	2
10	**Experiment No 10** To study speed control of a separately excited DC motor using a DC-DC chopper by varying duty cycle.	2
11	**Experiment No 11** To study the operation of a single phase voltage source inverter and observe output voltage waveform.	2
12	**Experiment No 12** To generate PWM signals and study their effect on inverter output voltage and harmonic reduction.	2
13	**Experiment No 13** To study the operation of a three phase inverter and observe line and phase voltages for different conduction modes.	2
14	**Experiment No 14** To study speed control of an induction motor using V/f control method by varying supply frequency.	2
15	**Experiment No 15** To study closed loop speed control of a DC motor using feedback and observe speed regulation characteristics.	2
Total Hours		**30**

Textbook :

1 Power Electronics-circuits, Devices and Applications, M.H. Rashid, PHI, 2005

2 Power Electronics: Converters, Applications, Ned Mohan, T.M. Undeland and William P. Robbins, John Wiley & Sons, 2009

3 Power Semiconductor Drives, S.B. Dewan, Gordon R. Slemon and A. Straughen, John Wiley Pub, 1996

4 Modern Power Electronics and AC Drives, B.K. Bose, Pearson, 2002

References:

1 Elements of Power Electronics, Elements of Power Electronics, Philip T. Krein, Oxford University Press, 1997

2 Principles of Power Electronics, Principles of Power Electronics, John G. Kassakian, Martin F. Schlect, Geroge C. Verghese, Pearson Education, 2010

3 Electronic motor drives modeling Analysis and control, Electronic motor drives modeling Analysis and control, R. Krishnan, Prentice Hall India, 2001

Suggested Theory Distribution:

The suggested theory distribution as per Bloom's taxonomy is as follows. This distribution serves as guidelines for teachers and students to achieve effective teaching-learning process

Distribution of Theory for course delivery					
Remember / Knowledge	**Understand**	**Apply**	**Analyze**	**Evaluate**	**Higher order Thinking / Creative**
5.00	10.00	30.00	20.00	20.00	15.00

Instructional Method:

1 The internal evaluation will be done based on the continuous evaluation of students in the laboratory and class-room.

2 A practical examination will be conducted at the end of the semester for evaluation of practical performance.

3 Students may use supplementary resources such as online videos, NPTEL videos, e-courses, Virtual Laboratory, etc.

4 The course delivery method will depend upon the requirements of content and need of the students. The teacher in addition to conventional teaching methods (Chalk and Talk) may use any of the tools/techniques such as demonstration, role play, Quiz, brainstorming, Flipped class, Project based learning, Collaborative learning, MOOCs etc. for effective teaching.

Supplementary Resources:

1 https://nptel.ac.in/courses/108101038

2 https://nptel.ac.in/courses/108106023

3 https://ocw.mit.edu/courses/6-622-power-electronics-spring-2023/

4 https://www.mathworks.com/help/sps/power-electronics-and-motor-drives.html

5 www.allaboutcircuits.com

6 https://www.electronics-tutorials.ws/

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