INSTITUTE	**FACULTY OF TECHNOLOGY**
PROGRAM	**MASTER OF TECHNOLOGY in ELECTRICAL ENGINEERING**
SEMESTER	**1**
COURSE TITLE	**POWER ELECTRONIC CONVERTERS IN EV**
COURSE CODE	**01EV1108**
COURSE CREDITS	**4**

Objective:

1 The objective of this course is to equip students with essential knowledge in the field of power electronics and advancements in the power electronic converters for electric and hybrid vehicles.

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

1 Differentiate between operational behaviour of IGBT and MOSFET and applications of devices.

2 Analyze performance parameters of rectifiers.

3 Evaluate different PWM schemes of Voltage Source Inverters.

4 Design different switched mode power supplies.

5 Develop a typical driver for power electronic switch.

Pre-requisite of course: Power Electronics

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	**Power Semiconductor Switches:** Desired Characteristics in Controllable Switches, Comparison of Controllable Switches, , Power MOSFET – Structure, Characteristics, Operation, Switching characteristics, Operation Limitation and Safe Operating Area, , IGBT – Structure, Characteristics, Latchup in IGBT, Operation, Switching characteristics, Operation Limitation and Safe Operating Area, , Comparison of Power MOSFET and IGBT, SiC MOSFET	4
2	**Gate Drive Circuit and Snubbers:** Electrically Isolated Drive Circuits , Optocoupler Isolated Drive Circuits, Transformer-Isolated Drive Circuits, , Blanking Times for Bridge Circuits, Circuit Layout Considerations for Power Converter,, Reduction of Stray Inductance in Bus Bars	6

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Contents : Unit	Topics	Contact Hours
3	**AC/DC Rectifiers:** Operation of Single-Phase Uncontrolled Rectifier, , Performance Parameters of controlled converters – Input Displacement Factor, Distortion Factor, Power Factor and Total Harmonic Distortion, Power Factor Improvement Techniques, , Multipulse Converters	8
4	**Pulse Width Modulated Inverters:** Concept of Switched Mode Inverters, Pulse-Width-Modulated Switching Scheme, , Square-Wave Switching Scheme, PWM Of Single-Phase Inverters, PWM of Three Phase Inverter,, Effect of Blanking Time on Voltage in PWM Inverters, , Concept of Zero Vector in PWM, Space Vector PWM, , Hysteresis Current Control, Rectifier Mode of Operation of PWM Inverter, Matrix Converter – Principle, Operation, Modulation Schemes of Matrix Converter	10
5	**Switched Mode Power Supply** Step-Down (Buck) Converter, , Step-up (Boost) Converter,, Buck-Boost Converter, , Cuk dc-dc Converter, , Full Bridge dc-dc Converter, Isolated Converters - Forward Converter, Flyback Converter	8
6	**Modelling and Control of Power Electronic Converters** Types of models – Switched model, average model, large signal and small signal model,, Switched model of power electronic converter, , Classical average model of converter,, generalized average model,, Control Principles of Power Electronic Converters, , Linear Control Approaches for Power Converters – A case study	6
Total Hours		**42**

Suggested List of Experiments:

Contents : Unit	Topics	Contact Hours
1	**Experiment List** Obtain dynamic characteristics of IGBT under different loading conditions., Design an opto-coupler based driver circuit for IGBT/MOSFET, Analyze the effect of snubber in the operation of IGBT based converter, Evaluate performance parameters of three phase converter with RL load., Simulate a 12-pulse converter and compare the performance with 6-pulse converter., Compare the performance of unipolar PWM and bipolar PWM scheme in single phase VSI., Develop sine PWM scheme for Three Phase VSI., Analyze the operation of Buck Converter under CCM and DCM., Analyze the operation of Boost Converter under CCM and DCM., Design an inductor/transformer for switch mode power supply.	20
2	**Experiment-2** Design an optocoupler-based driver circuit for IGBT/MOSFET (Use IGBT/MOSFET Driver)	2
3	**Experiment-3** Analyze the effect of snubber in the operation of IGBT-based converter	2

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Suggested List of Experiments:

Contents : Unit	Topics	Contact Hours
4	**Experiment-4** Evaluate performance parameters of three phase converter with RL load	2
5	**Experiment-5** Simulate a 12-pulse converter and compare the performance with 6-pulse converter	2
6	**Experiment-6** Compare the performance of unipolar PWM and bipolar PWM scheme in single phase VSI	2
7	**Experiment-7** Develop sine PWM scheme for Three Phase VSI	2
8	**Experiment-8** Analyze the operation of Buck Converter under CCM and DCM	2
9	**Experiment-9** Analyze the operation of Boost Converter under CCM and DCM	2
10	**Experiment-10** Design an inductor/transformer for switch mode power supply	2
Total Hours		**38**

Textbook :

1 Power electronics: a First Course, Mohan, Ned. , Wiley,, 2011

2 Thyristor DC drives, Sen, Paresh Chandra, John Wiley & Sons, 1981

References:

1 Power electronics: converters, applications, and design, Power electronics: converters, applications, and design, Mohan, Ned, and Tore M. Undeland, John wiley & sons,, 2007

2 Power electronics handbook, Power electronics handbook, Rashid, Muhammad H., ed, Butterworth-Heinemann, 2017

3 Modern power electronics and AC drives, Modern power electronics and AC drives, Bose, Bimal K. , Prentice hall, 2002

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 and evaluation					
Remember / Knowledge	**Understand**	**Apply**	**Analyze**	**Evaluate**	**Higher order Thinking / Creative**
5.00	10.00	15.00	30.00	20.00	30.00

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Instructional Method:

1 The course delivery method will depend upon the requirement of content and need of students. The teacher in addition to conventional teaching method by black board, may also use any of tools such as demonstration, role play, Quiz, brainstorming, MOOCs etc.

2 The internal evaluation will be done on the basis of continuous evaluation of students in the laboratory and classroom.

3 Practical examination will be conducted at the end of semester for evaluation of performance of students in laboratory

4 Students will use supplementary resources such as online videos, NPTEL videos, e-courses, Virtual Laboratory.

Supplementary Resources:

1 https://nptel.ac.in/content/storage2/courses/108105066/PDF/L-1(SSG)(PE)%20((EE)NPTEL).pdf

2 https://nptel.ac.in/courses/108/105/108105066/

3 https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-334-power-electronics-spring-2007/

4 https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-334-power-electronics-spring-2007/lecture-notes/chp1.pdf

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