COURSE TITLE	**BATTERY CHARGERS FOR ELECTRIC VEHICLES**
COURSE CODE	**01EE1706**
COURSE CREDITS	**3**

Objective:

1 Main objective of subject is to introduce different battery charger's topology, & analyse them for battery charging of electric vehicle with different modulation & control strategies.

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

1 Examine the idea of battery chargers and their various configurations.

2 Comprehend the principle of wirelessly charging batteries for electric vehicle (EV) use.

3 Assess the performance of a isolated DC-DC converter employed for electric vehicle charging purposes.

4 Evaluate the performance of different resonant converters within electric vehicle charging systems.

5 Analyse the operation and distinct modulation methods of the Dual Active Bridge Converter.

Pre-requisite of course: Power Electronics

Teaching and Examination Scheme

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

Contents : Unit	Topics	Contact Hours
1	**Introduction** Overview, Indian Scenario, Vehicle Charging station and future trends, Different Power level of EV battery chargers, Different types of connector guns and their specifications, Introduction of Power Converter Topologies and Charging Topologies for EV	4
2	**Isolated dc-dc converters** Flyback Converter, Forward Converter, Push-Pull Converter, Push-Pull Converter, Active clamp operation of flyback and forward converter	6
3	**LLC Resonant Converters** Overview of series, parallel and series-parallel resonance converter, Half bridge LLC resonant converter: topology, operation and control, Full bridge LLC resonant converter: topology, operation and control, TL-LLC resonant converter: topology, operation and control, design steps of LLC resonant converter	12

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Contents : Unit	Topics	Contact Hours
4	**Dual Active Bridge (DAB) Converter** Basic Principle of DAB Converters, Voltage-Fed DAB Converters and its control, Modulation techniques for Dual Active Bridge converters, Current-Fed DAB Converters, Unified Boundary Trapezoidal Modulation Control, Current-Fed Dual Active Bridge DC–DC Converter	12
5	**Wireless Power Transfer (WPT) for Electric Vehicles (EVs)** Basics of WPT Technology, Wireless Energy Transfer methods, Modelling the WPT System, WPT for EV Charging, Inductive Power Transfer systems, Capacitive Power Transfer System, Hybrid Inductive/Capacitive Power Transfer Systems, Magnetic Gear WPT system	8
Total Hours		**42**

Textbook :

1. Power Electronics Essentials and Applications, L. Umanand, Wiley India Ltd., 2009
2. Power Electronics – Converters, Applications and Design, Ned Mohan, Tore M. Undeland and William P. Robbins, John Willey & sons, Inc., 3rd ed., 2003
3. Power electronics: circuits, devices, and applications, M. H. Rashid, Pearson Education India, 2009
4. Resonant Power Converters, Marian K. Kazimierczuk, Dariusz Czarkowski, John Willey & sons, 2nd Edition, 2011
5. High-Frequency Isolated Bidirectional Dual Active Bridge DC–DC Converters with Wide Voltage Gain, Deshang Sha Guo Xu, Springer, Singapore, 2019

References:

1. Wireless Power Transfer – Recent Development, Applications and New Perspectives, Wireless Power Transfer – Recent Development, Applications and New Perspectives, Mohamed Zellagui, IntechOpen, 2021
2. Wireless Power Transfer (WPT) for Electric Vehicles (EVs)—Present and Future Trends, Wireless Power Transfer (WPT) for Electric Vehicles (EVs)—Present and Future Trends, D. M. Vilathgamuwa, J. P. K. Sampath, Springer Singapore, 2015
3. Wireless Charging technologies for electric vehicle: Inductive, Capacitive, and magnetic gear, Wireless Charging technologies for electric vehicle: Inductive, Capacitive, and magnetic gear, Ahmed A. S Mohamed, Ahmed, A. Shaier, Hamid Metwally, Sameh I. Selem, IET Power Electronics, 2020
4. Review on classification of resonant converters for electric vehicle application, Review on classification of resonant converters for electric vehicle application, Deshmukh (Gore), A. Iqbal, S. Islam, Energy Reports, vol. 8, pp. 1091–1113, 2022

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

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Distribution of Theory for course delivery					
Remember / Knowledge	**Understand**	**Apply**	**Analyze**	**Evaluate**	**Higher order Thinking / Creative**
10.00	20.00	25.00	25.00	10.00	10.00

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 et
2. The internal evaluation will be done on the basis of continuous evaluation of students in the laboratory and classroom.
3. Students will use supplementary resources such as online videos, NPTEL videos, e-courses.

Supplementary Resources:

1. https://www.plexim.com/de/support/application-examples/1506
2. https://imperix.com/doc/implementation/dual-active-bridge-control
3. https://www.typhoon-hil.com/documentation/typhoon-hil-application-notes/References/dab_with_sp_based_pwm.html
4. https://www.intechopen.com/chapters/75267
5. https://www.iitg.ac.in/e_mobility/WPT
6. https://www.ti.com/seclit/ml/slup263/slup263.pdf
7. http://www.witricity.com/assets/WiT-3300_ data_sheet.pdf

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