GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Minor/Hons. Program
Level: UG
Branch: Minor/Hons. Electrical Vehicles
Subject Code: BE050AL011
Subject Name: Power Electronics for Electrical Vehicles

w.e.f. Academic Year:	2026-27
Semester:	5
Category of the Course:	Core Courses

Prerequisite:	Electrical Machines, basic Power Electronics Devices, Circuits and Applications
Rationale:	The use of Power electronics will play important role in making highly efficient electric vehicles having low pollution and better fuel economy. This subject will be helpful to enhance the knowledge of Power Electronics used in up-coming electrical vehicle technology.

Course Outcomes:

Sr. No.	CO statements	Marks % weightage
CO-1	Discuss the configuration and performance of Electric & hybrid vehicles.	20
CO-2	Select appropriate Motor drive systems for electrical and Hybrid vehicle.	30
CO-3	Choose proper energy storage systems with its charging topology for electrical and hybrid vehicle applications.	25
CO-4	Discuss energy storage devices and its management System for hybrid and electrical vehicle.	15

Teaching and Examination Scheme:

Teaching / Learning Scheme (in Hours per semester)					Total Credits	Assessment Pattern and Marks					Total Marks
						Theory		Tutorial / Practical			
L	T	P	PBL*	TH		ESE (E)	PA(M)	PA (I)	PBL (I)	ESE (V)	
60	0	30	60	150	5	70	0	0	30	50	150

Contents:

Sr. No.	Content	Total Hrs
1	**Introduction:** Electric and Hybrid Electric Vehicles, Configuration of Electric Vehicles, Performance of Electric Vehicles, Traction motor characteristics, Tractive effort and Transmission requirement, Vehicle performance, Tractive effort in normal driving, Energy consumption, Concept of Hybrid Electric Drive Trains, Architecture of Hybrid Electric Drive Trains, Series Hybrid Electric Drive Trains, Parallel hybrid	10

	electric drive trains.	
2	**Power Electronics and Automotive Semiconductor Devices:** Introduction, Power Electronics System – Its Building Blocks and Components, Construction, Working and Characteristics of Power Devices: Power Diodes, Metal Oxide Semiconductor Field Effect transistors (MOSFET), SIC MOSFET and GaN MOSFET, Insulated Gate Bipolar Transistors (IGBTs), Advance Material used for Power Devices.	**8**
3	**Electric motor drive train application in EV:** Induction motor drive application in EV, Switched Reluctance motor drive application in EV, BLDC/PMSM drive application in EV, Types of Electric motors & their suitability to EV applications, Configuration of Electric Vehicle based on Electric drive train.	**8**
4	**Automotive Power Electronics Converters:** DC-DC Converters- Chopper Basics, Types, Buck, Boost, and Buck- Boost Converter Commonalities, Principle of operation, Quadrant operation -AC-DC Converters- Diode uncontrolled Rectifiers, Types, working with different types of loads. Thyristor controlled Rectifiers, Types, working with different types of loads, DC-AC inverters- Single phase and Three phase configuration, Voltage source Inverter and Current Source Inverter, Multilevel inverter. Working operation with different type of loads	**14**
5	**Electric Vehicle Charging system and Fuel cell based Electric Vehicles:** Battery Types, Battery charging basics, Charging control methods, Charging technologies for light electric vehicle, AC and DC charging system, Power Electronic converter for EV battery charger, Fuel Cell, Ultra Capacitor	**6**
	Hydrogen Fuel Cell (HFC) Technology: Introduction to HFC technology-Fuel cell stacking and system integration-Types of hydrogen fuel cells-Power conditioners for HFC systems-Cost and size considerations in HFC power conversion-Hybrid EVs with HFC integration-Auxiliary power systems based on HFC-Calculations of rating, efficiency, and cost for HFC power systems	**6**
6	**Battery Management System:** Introduction to battery management system, BMS classification based on features and topology, Distributed BMS, Centralized BMS, Charge balancing requirement of batteries, Passive cell Balancing, Active cell Balancing, State of Charge (SoC) Estimation, Battery state of Health (SoH), Battery Depth of Discharge	**8**
TOTAL		**60**

Suggested Specification table with Marks (Theory): (For B.E. only)

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
20	**40**	**20**	**10**	**10**	**00**

R: Remembrance; U:Understanding; A:Application, N:Analyze, E:Evaluate C:Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books:

1. Muhammad H. Rashid, Power Electronics: Circuits, Devices and Applications, Pearson Education, New Delhi
2. Ned Mohan, Tore M. Undeland and William P. Robbins, Power Electronics: Converters, Applications and Design, John Wiley & Sons, Inc., New York
3. B. Jayant Baliga, Power Semiconductor Devices, Thompson Course Technology, Singapore
4. L Umanand, Power Electronics, Essentials & Applications, Wiley India
5. M. S. Jamil Asghar, Power Electronics, Prentice-Hall of India Pvt. Ltd., New Delhi
6. P. S. Bhimbra, Power Electronics, Khanna Publishers, New Delhi
7. M. D. Singh and K. B. Khanchandani, Power Electronics, Tata McGraw-Hill Publishing Company Ltd., New Delhi
8. Chetan Singh Solanki, Solar Photovoltaics: Fundamentals, Technologies and Applications, Prentice Hall, New Delhi
9. Joseph Vithayathil, Power Electronics, Principles and Applications, Indian Edition, McGraw-Hill
10. Research Papers on IEEE/IET/Science Direct etc

List of Experiments:

1. Static and dynamic characteristic of SCR, MOSFET and IGBT
2. Demonstrate single phase SCR full-controlled bridge converter with different loads
3. Modeling and simulation of closed-loop control of DC-DC Buck/Boost/Buck-Boost converter.
4. Performance of 1-phase bridge inverter with R and R-L load
5. Design and perform the three-phase voltage source inverter in 180 and 120-degree mode of conduction

6. Simulation of SVPWM and to study its effectiveness over SPWM.
7. Perform single phase semi-controller rectifier with R and RL load application
8. Design and simulate single phase ac-ac converter with R load
9. Prepare report on application of power electronics in renewable energy source power conversion
10. Develop the simulation of single-phase dual converter.

Major Equipment:

- SCR, MOSFET and IGBT device characteristics trainer board
- Single phase and three phase rectifiers
- Single phase and three phase inverters
- Buck, Boost and Buck-boost Converter
- Control circuit for inverter
- Various controllers for designing the control circuit
- Various Sensors for close loop operation

List of Open Source Software

1. Scilab (https://www.scilab.org/) – An open-source alternative to MATLAB
2. PSIM (Free Version) / OpenModelica (https://openmodelica.org/) – For modeling and simulating power electronics circuits

List of learning website:

1. MIT Open Course Ware (https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/) – Free courses on electrical machines and power electronics.
2. Circuit Lab (Free with limited access) (https://www.circuitlab.com/) – Web-based circuit simulator
3. Virtual Labs by IITs (Government of India Initiative) (https://vlab.co.in/) – Simulations and experiments related to Power electronics.
4. Reputed Research Journal Website

List of suggested activities for Term Work / Self Learning:

Sr. No.	Name of the activity	No. of hours	Evaluation Criteria
1	Industry/Research laboratory visit	Visit = 5h, Report preparation = 5h Total = 10h	Based on report submitted. Report should contain observations and calculations based on industry/ lab data.

2	Technical Video based learning related to the subject	Duration of video = 5h Report preparation = 5h Total = 10h	Report /presentation based on the video learning outcomes.
3	Assignment writing. Numerical based assignment is preferable.	5 assignments of 2h each. Total = 10h	Based on the assignment submitted.
4	Self learning on-line course	Minimum duration of the course should be 10h.	Examination based assessment at the end of course. Based on the certificate produced.
5	Complex problem solving	Maximum 2 problems. Study of the problem and solution finding, Total = 10h	Based on the depth of the solution submitted.
6	Discussion on research paper based on relevant subject	5 research paper = 20 h	Summarize research paper and evaluation critical parameters
7	Poster/chart/power point preparation on technical topics	Duration = 6 h	Based on poster/chart preparation and presentation skills
8	Working/non-working model on technical topics	Working = 12 h Non-working = 8 h	Based on inter department/external evaluation
9	Group Discussion on emerging/trending technical topics based on subject	Duration = 1 h each	Based on performance in group discussion, technical depth, knowledge etc.
10	Real world case studies based learning	Duration of data collection/study = 5h Report preparation = 5h Total = 10h	Based on in-depth study, technical depth, data collected, fact finding, etc.
11	Blog or Technical Article Writing	10h (Research – 6h, Writing – 4h)	Based on originality, technical content, references cited, and clarity of communication.
12	Annotated Video Explanation of Concept/Problem	10h (Preparation + Recording + Submission)	Based on accuracy of explanation, clarity, and presentation style.
13	Online Technical Quizzes/Simulations	Multiple quizzes summing up to 10h	Based on quiz scores and reflection report after each quiz.
14	Patent Search and Innovation Gap Identification	10h (Search + Report)	Based on number of relevant patents analyzed and

			identification of innovation scope.

Note:

- All the suggested activities should be related to the subject
- The number of hours is suggestive. Faculty can sub-divide the number of hours based on the activity
- However, total number of hours is fixed. Rubrics for the evaluation can be prepared by the faculty.
- All records pertaining to the evaluation and assessment of self-learning activities must be properly maintained and preserved at the institute level. These records should be made available to the university upon request.
- Institutes are encouraged to utilize digital platforms, such as Microsoft Teams, for effective record keeping and to ensure transparency in the evaluation and assessment of self-learning activities.

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