

COURSE STRUCTURE AND DETAILED SYLLABUS

ELECTRICAL AND ELECTRONICS ENGINEERING

for

M.Tech. – Power Electronics & Drives

(Applicable from 2025-2026 Batches)



UNIVERSITY COLLEGE OF ENGINEERING KAKINADA

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY: KAKINADA

KAKINADA - 533 003, ANDHRA PRADESH, INDIA

Vision:

To be a premier institute of excellence developing highly talented holistic human capital that contributes to the nation through leadership in technology and innovation through engineering education.

Mission:

1. To impart Personnel Skills and Ethical Values for Sustainable Development of the Nation.
2. To create Research & Industry oriented centers of excellence in all engineering disciplines.
3. To be a renowned IPR generator and repository for innovative technologies.
4. To develop Research and Industry oriented technical talent.
5. To benchmark globally the academic & research output.

Vision and Mission of the Department

Vision:

To be in the forefront in education for meeting the needs of academic, research and industry in the areas of Electrical & Electronics Engineering, and make the department a centre of academic excellence.

Mission:

1. To provide the requisite theoretical and practical knowledge by offering appropriate courses.
2. To promote research oriented innovation culture among the students.
3. To create social awareness and ethical values in the graduates for betterment of the society.
4. To help the students in building professional capabilities in Electrical & Electronics Engineering.

M.Tech Program Course Structure & Syllabus

Program Educational Objectives (PEOs)

PEO1	Build a self-learning capability to deal with constantly evolving tools and technology and work effectively throughout their career.
PEO2	Utilize the concepts of Power Electronics & Drive systems to develop environment friendly & sustainable technologies.
PEO3	Impart professional knowledge in the field of Power Electronics & Drives and its applications in power sectors and core industries.

Mapping of PEOs with Mission statements

	PEO1	PEO2	PEO3
M1	3	2	2
M2	2	3	3
M3	1	2	1

Program Outcomes (POs):

PO1	An ability to independently carry out research /investigation and development work to solve practical problems.
PO2	An ability to write and present a substantial technical report/document.
PO3	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program.
PO4	An ability to analyze, design and apply control methodologies for digital control of power converters and drives.
PO5	An ability to select power electronic converters for drives and power system applications.

Mapping of Program Outcomes to PEOs

	PEO1	PEO2	PEO3
PO1	3	3	3
PO2	2	1	1
PO3	3	3	3
PO4	3	2	3
PO5	2	2	3

COURSE STRUCTURE
M.Tech I – Semester

S. No.	Course Code	Course Title	L	T	P	C
1		Program Core – 1 Electrical Machine Modeling and Analysis	4	0	0	4
2		Program Core – 2 Analysis of Power Electronic Converters	3	1	0	4
3		Program Core – 3 Digital Controllers for Power Electronic Applications	4	0	0	4
4		Program Elective – 1	3	0	0	3
5		Program Elective – 2	3	0	0	3
6		Laboratory – 1 Power Converters Simulation Laboratory	0	0	4	2
7		Laboratory – 2 Power Converters Laboratory	0	0	4	2
8		Technical Seminar-I	0	0	2	1
		TOTAL	15	5	6	23

Program Elective – 1 & 2

- i.Modern Control Theory
- ii.Power Quality Enhancement using Custom Power Devices
- iii.AI Applications in Power Electronics
- iv.Renewable Energy Technologies
- v.HVDC Transmission and Flexible AC Transmission Systems
- vi.Wide band gap devices

M.Tech II – Semester

S. No.	Course Code	Course Title	L	T	P	C
1		Program Core – 4 Switched Mode Power Conversion	3	1	0	4
2		Program Core – 5 Power Electronic Control of Electrical Drives	4	0	0	4
3		Program Core – 6 Electric and Hybrid Electric Vehicles	4	0	0	4
4		Program Elective – 3	3	0	0	3
5		Program Elective – 4	3	0	0	3
6		Laboratory – 3 EVs and Battery Technologies lab	0	0	4	2
7		Laboratory – 4 Digital Controllers and Electric Drives Laboratory	0	0	4	2
8		Technical Seminar – II	0	0	2	1
		TOTAL	15	5	6	23

Program Elective – 3 & 4

- i.Power Converters for Micro Grid
- ii. Battery Management Systems and Charging Stations
- iii. Advanced Digital Signal Processing
- iv. Applications of Power Converters
- v. Digital Control Systems
- vi. Industrial Internet of Things

M.Tech III – Semester

Sl. No.	Course Code	Course Title	L	T	P	C
1		Research Methodology and IPR / <i>Swayam 12 week MOOC course – RM&IPR</i>	3	0	0	3
2		Summer Internship/ Industrial Training (8-10 weeks)*	-	-	-	3
3		Comprehensive Viva [#]	-	-	-	2
4		Dissertation Part – A ^{\$}	-	-	20	10
		TOTAL	3	-	20	18

* Student attended during summer / year break and assessment will be done in 3rd Sem.

Comprehensive viva can be conducted courses completed up to second sem.

\$ Dissertation – Part A, internal assessment

M.Tech IV – Semester

Sl. No.	Course Code	Course Title	L	T	P	C
1		Dissertation Part – B [%]	-	-	32	16
		TOTAL	-	-	32	16

% External Assessment

M.Tech. I-Semester

COURSE CODE – R2511XXYY	Electrical Machines Modeling and Analysis (Program Core – 1)	Category PC	L-T-P 4-0-0	Credits 4
--------------------------------	---	--------------------	--------------------	------------------

Pre-requisite: Electric Circuits & Electrical Machines.

Course Outcomes:

At the end of the course, student will be able to

		Knowledge Level (K)#
CO1	Explain the fundamental modeling principles and reference frame transformations for DC, induction, synchronous, and special electrical machines.	2
CO2	Develop mathematical and state-space models for various electrical machines using transformation and circuit equations.	3
CO3	Analyze steady-state and transient machine performance under varying operational conditions.	4

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	2	1	2	3	2
CO2	3	2	3	3	3
CO3	3	1	3	3	3

(Please fill the above with Levels of Correlation, viz., L, M, H)

UNIT	CONTENTS	Contact Hours
UNIT – 1	Basic Concepts of Modeling & DC Machine Modeling: Basic two-pole D.C. machine - Primitive 2-axis machine – Voltage and Current relationship – Torque equation. Mathematical model of separately excited D.C. motor and D.C. Series motor in state variable form – Mathematical model of D.C. shunt motor and D.C. Compound motor in state variable form, Steady state analysis – Transient state analysis, Transfer function of the D.C. motor, Sudden application of inertia load.	
UNIT – 2	Reference Frame Theory & 3-phase Induction Motor dq model: Linear transformation – Phase transformation (abc to $\alpha\beta 0$) – Power equivalence, Active transformation ($\alpha\beta 0$ to $dq0$), transformations in complex plane, Commonly used reference frames and transformation between reference frames, Circuit model of a 3 phase Induction motor – Flux linkage equation – dq transformation of flux linkages in the complex plane – voltage equations	
UNIT – 3	Modeling of 3-phase Induction motor in various reference frames Voltage equation transformation to a synchronous reference frame, dq model of induction motor in the stator reference frame, rotor reference frame and arbitrary reference frame, power equation, electromagnetic torque equation, state space model in induction motor with flux linkages as variables and current-flux variables	
UNIT – 4	Modeling of 3-phase Synchronous Motor Synchronous machine inductances – Circuits model of a 3-phase synchronous motor – derivation of voltage equations in the rotor's dq0 reference frame electromagnetic torque – State space model with flux linkages as variables.	
UNIT – 5	Modeling of Special Machines: PMSM and BLDC Motor torque generation and comparison, Types of PMSM, PMSM dynamic modeling – SPMSM modeling in the abc frame, d-q stationary and d-q synchronous reference frame, IPMSM modeling in the d-q stationary and d-q synchronous reference frame, Block diagram for control,	

	Modeling of Brushless DC Motor, Block diagram for control, Modeling of Switched Reluctance Motor.	
	Total	

Text Books

1. Generalized theory of Electrical Machines -Fifth edition, Khanna Publishers P. S. Bimbhra, 1985.
2. AC Motor control and electric vehicle applications – Kwang Hee Nam – CRC press, Taylor & Francis Group, 2010.
3. Introduction to Modern Analysis of Electrical Machines and Drives -Wiley-IEEE Press- Paul C. Krause, Thomas C. Krause, 2023.

Reference Books:

1. Analysis of Electric Machinery and Drive Systems, 3rd Edition-Wiley-IEEE Press- Paul Krause, Oleg Wasynczuk, Scott Sudhoff, Steven Pekarek, 2013
2. Control of Electric Machine Drive Systems, Seung-Ki Sul, IEEE Press, A John Wiley & Sons, Inc. Publications. 2011.
3. Electric Motor Drives - Modeling, Analysis& control -R. Krishnan- Pearson Publications.

M.Tech. I-Semester

COURSE CODE – R2511XXYY	Analysis of Power Electronic Converters (Program Core – 2)	Category PC	L-T-P 3-1-0	Credits 4
--------------------------------	---	--------------------	------------------------	----------------------

Pre-Requisite: Power Electronics**Course Outcomes:** At the end of the course, student will be able to

		Knowledge Level (K)#
CO1	Understand the characteristics and switching behavior of modern power devices and corresponding gate driver circuits. Understand the operation of AC-DC converters, two-level inverters and various multilevel inverter configurations.	2
CO2	Apply various control strategies to improve input power quality and perform harmonic reduction in AC-DC conversion systems.	3
CO3	Analyze and compare different PWM techniques for two-level and multi-level inverters to reduce harmonics.	4

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	2	1	2	3	3
CO2	3	1	3	3	3
CO3	3	1	3	3	3

(Please fill the above with Levels of Correlation, viz., L, M, H)

UNIT	CONTENTS	Contact Hours
UNIT – 1	Overview of Switching Devices Power MOSFET, IGBT, GTO, GaN Devices-Static and Dynamic Characteristics, Gate Drive Circuits for Switching Devices.	
UNIT – 2	AC-DC Converters Single phase fully controlled converters with RL load– Evaluation of input power factor and harmonic factor- Continuous and Discontinuous load current, Power factor improvements, Extinction angle control, symmetrical angle control, PWM control. Three Phase AC-DC Converters, fully controlled converters feeding RL load with continuous and discontinuous load current, Evaluation of input power factor and harmonic factor-three phase dual converters.	
UNIT – 3	Active Front End Converters PF and THD, The Problem of Power Factor in Single-Phase Line-Commutated Rectifiers, Standards for Harmonics in Single-Phase Rectifiers, The Single-Phase Boost Rectifier, Voltage Doubler PWM Rectifier, The PWM Rectifier in Bridge Connection, Applications of Unity Power Factor Rectifiers, Three phase boost PFC converter.	
UNIT – 4	PWM Inverters: Voltage control of single-phase inverters employing phase displacement Control, Bipolar PWM, Unipolar PWM. Three-phase Voltage source inverters: Six stepped VSI operation-Voltage Control of Three-Phase Inverters employing Sinusoidal PWM, Third Harmonic PWM, Space Vector Modulation- SHE PWM- Comparison of PWM Techniques- Three phase current source inverters.	
UNIT – 5	Multilevel Inverters: Diode-Clamped Multilevel Inverter, Principle of Operation, Improved Diode Clamped Inverter, Cascaded H-bridge Multilevel Inverter, Principle of Operation, Fault tolerant operation of CHB Inverter, Comparison of DCMLI & CHB, Modular multilevel converters, principle of operation. PWM Multilevel Inverters: CHB Multilevel Inverter: Stair case modulation-SHE PWM- Phase shifted	

	Multicarrier Modulation-Level shifted PWM- Diode clamped Multilevel inverter: SHE PWM-Sinusoidal PWM- Space vector PWM-Capacitor voltage balancing.	
	Total	

Text Books

1. Power Electronics: Converters, Applications, and Design- Ned Mohan, Tore M. Undeland, William P. Robbins, John Wiley & Sons, 2nd Edition ,2003.
2. Power Electronics-Md.H.Rashid –Pearson Education Third Edition- First Indian Reprint-2008.

Reference Books:

1. Power Electronics Semiconductor Switches – Ram Shaw, 1993.
. Power Electronics Daniel W. Hart - McGraw-Hill, 2011.
2. Elements of Power Electronics – Philip T. Krein, Oxford University press, 2014.
3. Power Converter Circuits – William Shepherd & Li Zhang-Yes Dee CRC Press, 2004.

M.Tech. I-Semester

COURSE CODE – R2511XXYY	Digital Controllers for Power Electronic Applications (Program Core – 3)	Category PC	L-T-P 4-0-0	Credits 4
------------------------------------	---	------------------------	------------------------	----------------------

Pre-requisite:**Course Outcomes:** After the completion of the course, student will be able to

		Knowledge Level (K)#
CO1	Explain FPGA architectures, programming technologies, and microcontroller-based control principles for power electronic applications.	2
CO2	Develop digital control circuits and gate pulse generation systems for converters and inverters using FPGA and microcontroller platforms.	3
CO3	Analyze and compare FPGA- and microcontroller-based control strategies for high-performance power converter applications.	4

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	2	2	2	3	2
CO2	3	2	3	3	3
CO3	3	1	3	3	3

(Please fill the above with Levels of Correlation, viz., L, M, H)

UNIT	CONTENTS	Contact Hours
UNIT – 1	Field Programmable Gate Arrays: FPGA resources - Logic Blocks and Interconnection Resources, Main FPGA Architectures, Implementation Process for FPGAs Programming Technologies - Static RAM Programming, Anti Fuse Programming, EPROM and EEPROM Programming Technology, Commercially available FPGAs - Xilinx FPGAs, Altera FPGAs, FPGA Design Flow Example - Initial Design Entry, Translation to XNF Format, Partitioning, Place and Route, Performance Calculation and Design Verification.	
UNIT – 2	Xilinx Artix-7 series FPGA over view: CLB Overview, 7 Series CLB Features, Device Resources, Recommended Design Flow, CLB Arrangement, Slice Description, Look-Up Table (LUT), Basys-3 & Nexys A7 FPGA Boards – Features, Walk Around the Board, Power, FPGA Configurations, Memory, Oscillators/ Clocks, USB-UART Bridge (Serial Port), USB HID Host, Basic I/O, Pmod Ports.	
UNIT – 3	Implementation of simple digital circuits using FPGA hardware: System Generator Design Flow, Xilinx Blocks – Basic elements, Math, Matlab I/O, Generation of gate pulses for DC-DC converters and three phase inverters with system generator, Simulink Hdl coder block set, HDL Counter – Counter Modes, Control Ports, Defining the Counter Data Type and Size, Parameters, Generation of gate pulses for DC-DC converters and three phase inverters with HDL coder, WAVECT block set in MATLAB, model development and HDL code generation.	
UNIT – 4	Introduction to C2000 Microcontroller: C2000 Family of Microcontrollers; Fixed point and Floating point processing units; Architectures of C28x processors; Types of memory in C2000 and their mapping, Introduction to CPU Timers and Resets, Interrupts – Peripheral interrupts, Exceptions, and non-maskable	

	Interrupts; Introduction to GPIO; Configuration overview; GPIO and Peripheral muxing; Introduction to ADC; Principle of operation; configurations; ADC registers and Interrupts; Introduction to DAC; Operation sequence; DAC registers;	
UNIT – 5	Enhanced Pulse Width Modulation (ePWM) Peripheral: Introduction to ePWM; ePWM architecture; sub modules- Time base module, counter compare, Action qualifier, Dead-band module, PWM chopper module, Trip-zone and Event trigger module, Digital compare module; ePWM registers; Introduction to High-Resolution PWM (HRPWM); Programming examples- Fixed and variable duty PWM generation, Dead band generation, 3-phase ePWM signals generation.	
	Total	48 Hrs

Text Books:

1. FPGA-Based System Design Wayne Wolf, Verlag: Prentice Hall
2. Field Programmable Gate Array Technology - Stephen M. Trimberger, Springer International Edition
3. Hamid.A.Toliat and Steven G.Campbell, ‘DSP Based Electromechanical Motion Control’ CRC Press New York , 2004.
4. TMS320F28004x Real-Time Microcontrollers- Technical Reference Manual
5. Getting Started With C2000™ Real-Time Control Microcontrollers (MCUs)- Technical reference Manual

References:

1. Basys 3™ and Nexys A7™ FPGA Board Reference Manual from Digilent Technologies
2. Xilinx System Generator v2.1 for Simulink, Chapter – 1, 3, 7.
3. Getting Started Tutorial WAVECT WCU100/WCU200 user guide from Entuple Technologies.
4. C2000™ Microcontroller Workshop guide Manual, Texas Instruments
5. https://softwaredl.ti.com/trainingTTO/trainingTTO_public_sw/c28x28069/C28x_Microcontroller_MDW_5-0.pdf

COURSE CODE – R2511XXYY	Modern Control Theory (Program Elective –1 & 2)	Category PE	L-T-P 3-0-0	Credits 3
------------------------------------	--	------------------------	------------------------	----------------------

Pre-requisite: Control Systems, differential equations.

Course Outcomes: At the end of the course, student will be able to,

		Knowledge Level (K)#
CO1	Explain state-space modeling concepts, controllability, observability, and the design of state feedback controllers and observers for linear and nonlinear systems.	
CO2	Analyze linear, nonlinear, and time-varying systems for stability using state-space, describing function, and Lyapunov's methods.	
CO3	Develop and evaluate optimal and state feedback control strategies for dynamic systems using modern control techniques.	

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	3	2	3	3	2
CO2	3	1	3	3	2
CO3	3	2	3	3	3

(Please fill the above with Levels of Correlation, viz., L, M, H)

UNIT	CONTENTS	Contact Hours
UNIT – 1	State Variable Analysis The concept of state – State Equations for Dynamic systems– Solution of Linear Time Invariant Continuous-Time State Equations, State transition matrix and it's properties. Controllability and Observability of state model in Jordan Canonical form - Controllability and Observability Canonical forms of State model	
UNIT – 2	Design using state variable technique Design of state feedback controller through pole placement technique- Necessary and sufficient condition- Ackermann's formula. Concept of observer-Design of full order state observer-reduced order observer.	
UNIT – 3	Non Linear Systems Classification of Nonlinearities- common physical nonlinearities– Characteristics of nonlinear systems - Singular Points –Linearization of nonlinear systems– Describing function – describing function analysis of nonlinear systems- Stability analysis of Nonlinear systems through describing functions, Introduction to phase plane analysis, Method of Isoclines for Constructing Trajectories.	
UNIT – 4	Stability Analysis Stability in the sense of Lyapunov, Lyapunov's stability and Lyapunov's instability theorems – Stability Analysis of Linear Continuous time invariant systems by Lyapunov method – Generation of Lyapunov functions – Variable gradient method – Krasovskii's method.	
UNIT – 5	Introduction to Optimal Control Minimization of functional of single function – Constrained minimization – Minimum principle – Control variable inequality constraints – Control and state variable inequality constraints – Euler lagrangine equation. Typical optimal control performance measures-optimal control based on Quadratic performance measures- Quadratic optimal regulator systems- State regulator problems –Output regulator problems.	
	Total	

Text Books:

1. Modern Control Engineering – by K. Ogata, Prentice Hall of India, 3rd edition, 1998.
2. Automatic Control Systems by B.C. Kuo, Prentice Hall Publication.

Reference Books:

1. Modern Control System Theory – by M. Gopal, New Age International Publishers, 2nd edition, 1996
2. Control Systems Engineering by I.J. Nagarath and M.Gopal, New Age International (P) Ltd.
3. Digital Control and State Variable Methods – by M. Gopal, Tata McGraw–Hill Companies, 1997.
4. Systems and Control by Stainslaw H. Zak , Oxford Press, 2003.
5. Optimal control theory: an Introduction by Donald E.Kirk by Dover publications.
6. Modern control systems, Richard C. Dorf and Robert H. Bishop, 11th Edition, Pearson Edu, India, 2009

M.Tech. I-Semester

COURSE CODE – R2511XXYY	Power Quality Enhancement Using Custom Power Devices (Program Elective –1 & 2)	Category PE	L-T-P 3-0-0	Credits 3
------------------------------------	---	------------------------	------------------------	----------------------

Pre requisite: Knowledge on electric circuit analysis, power systems and power electronics and concept of reactive power compensation techniques.

Course Outcomes: At the end of the course, student will be able to

		Knowledge Level (K)#
CO1	Explain various power quality issues, their sources, and the principles of voltage regulation, transient mitigation, and harmonic control in power systems.	
CO2	Analyze power quality problems and evaluate the performance of mitigation devices such as voltage regulators, harmonic filters, and custom power devices.	
CO3	Design and develop control strategies for custom power devices like DVR, UPQC, and IPFC to enhance power quality and system reliability.	

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	3	2	2	3	2
CO2	3	2	3	3	3
CO3	3	2	3	3	3

(Please fill the above with Levels of Correlation, viz., L, M, H)

UNIT	CONTENTS	Contact Hours
UNIT – 1	Introduction to power quality: Overview of Power Quality, Concern about the Power Quality, General Classes of Power Quality Problems, Voltage Unbalance, Waveform Distortion, Voltage fluctuation, Power Frequency Variations, Power Quality Terms, Voltage Sags, swells, flicker and Interruptions - Sources of voltage and current interruptions, Nonlinear loads.	
UNIT – 2	Transient and Long Duration Voltage Variations: Source of Transient Over Voltages - Principles of Over Voltage Protection, Devices for Over Voltage Protection, Utility Capacitor Switching Transients, Utility Lightning Protection, Load Switching Transient Problems. Principles of Regulating the Voltage, Device for Voltage Regulation, Utility Voltage Regulator Application, Capacitor for Voltage Regulation, End-user Capacitor Application, Regulating Utility Voltage with Distributed generation	
UNIT – 3	Harmonic Distortion and solutions: Voltage vs. Current Distortion, Harmonics vs. Transients - Power System Quantities under Non-sinusoidal Conditions, Harmonic Indices, Sources of harmonics, Locating Sources of Harmonics, System Response Characteristics, Effects of Harmonic Distortion, Inter harmonics, Harmonic Solutions Harmonic Distortion Evaluation, Devices for Controlling Harmonic Distortion, Harmonic Filter Design, Standards on Harmonics	
UNIT – 4	Custom Power Devices: Custom power and custom power devices, voltage source inverters, reactive power and harmonic compensation devices, compensation of voltage interruptions and current interruptions, static series and shunt compensators, compensation in distribution systems, interaction with distribution equipment, installation considerations.	
UNIT – 5	Application of custom power devices in power systems: Static and hybrid Source Transfer Switches, Solid state current limiter - Solid state breaker. P-Q theory – Control of P and Q, Dynamic Voltage Restorer (DVR), Operation and control of Interline Power Flow Controller (IPFC), Operation and control of Unified Power Quality Conditioner (UPQC), Generalized power quality	

	conditioner.	
	Total	

Text Books:

1. Electrical Power Systems Quality, Dugan R C, McGranaghan M F, Santoso S, and Beaty H W, Second Edition, McGraw-Hill, 2002.
2. Understanding Power Quality Problems: Voltage Sags and Interruptions, Bollen M H J, First Edition, IEEE Press; 2000.
3. Guidebook on Custom Power Devices, Technical Report, Published by EPRI, Nov 2000
4. Power Quality Enhancement Using Custom Power Devices – Power Electronics and Power Systems, Gerard Ledwich, Arindam Ghosh, Kluwer Academic Publishers, 2002.

Reference Books:

1. Power Quality Primer, Kennedy B W, First Edition, McGraw-Hill, 2000.
2. Power System Harmonics, Arrillaga J and Watson N R, Second Edition, John Wiley & Sons, 2003.
3. Electric Power Quality control Techniques, W. E. Kazibwe and M. H. Sendaula, Van Nostrand Reinhold, New York.
4. Power Quality c.shankaran, CRC Press, 2001
5. Harmonics and Power Systems –Franciso C.DE LA Rosa-CRC Press (Taylor & Francis).
6. Power Quality in Power systems and Electrical Machines-EwaldF.fuchs, Mohammad A.S. Masoum-Elsevier
7. Power Quality, C. Shankaran, CRC Press, 2001
8. Instantaneous Power Theory and Application to Power Conditioning, H. Akagiet.al., IEEE Press, 2007.
9. Custom Power Devices - An Introduction, Arindam Ghosh and Gerard Ledwich, Springer, 2002
10. A Review of Compensating Type Custom Power Devices for Power Quality Improvement, Yash Pal et.al., Joint International Conference on Power System Technology and IEEE Power India Conference, 2008. POWERCON 2008.

M.Tech. I-Semester

COURSE CODE – R2511XXYY	AI Applications in power Electronics (Program Elective –1 & 2)	Category PE	L-T-P 3-0-0	Credits 3
------------------------------------	---	------------------------	------------------------	----------------------

Pre –requisite: Fundamentals of Neural networks and Fuzzy Logic**Course Outcomes:** At the end of the course, student will be able to,

		Knowledge Level (K)#
CO1	Explain the fundamentals of artificial neural networks, learning paradigms, classical and fuzzy sets, and fuzzy logic systems for control applications.	
CO2	Analyze and design neural network and fuzzy logic-based controllers for power electronic applications such as PWM generation and motor speed control.	
CO3	Develop and implement AI-based solutions for practical power system and drive applications using neural networks and fuzzy logic controllers.	

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	3	2	3	2	2
CO2	3	2	3	3	3
CO3	3	2	3	3	3

(Please fill the above with Levels of Correlation, viz., L, M, H)

UNIT	CONTENTS	Contact Hours
UNIT – 1	Introduction Artificial Neural Networks (ANN) – Humans and computers – Biological neural networks – ANN Terminology – Models of Artificial neuron – activation functions –typical architectures – biases and thresholds – learning strategy(supervised, unsupervised and reinforced) learning rules, perceptron training and classification using Discrete and Continuous perceptron algorithms, ADALINE and MADLINE – linear separability and non-separability with examples.	
UNIT – 2	ANN Paradigms Generalized delta rule – Back Propagation algorithm- Radial Basis Function (RBF) network. Kohonen’s self-organizing feature map (KSOFM), Learning Vector Quantization (LVQ) – Functional Link Networks (FLN) – Bidirectional Associative Memory (BAM) – Hopfield Neural Network.	
UNIT – 3	Classical and Fuzzy Sets Introduction to classical sets - properties, Operations and relations; Fuzzy sets, Membership, Uncertainty, Operations, properties, fuzzy relations, cardinalities, membership functions.	
UNIT – 4	Fuzzy Logic Controller (FLC) Fuzzy logic system components: Fuzzification, Inference engine (development of rule base and decision-making system), Defuzzification to crisp sets- Defuzzification methods.	
UNIT – 5	Application of AI Techniques: Selected Harmonic Elimination PWM using feed forward neural network, instantaneous current control PWM using neural network, Speed control of DC motor using Fuzzy logic, Speed control of Induction motor using Fuzzy logic.	
	Total	

Text Books:

1. Fundamentals of Neural Networks: Architectures, Algorithms and Applications by Laurene Fausett, Pearson Education, 2008.
2. Introduction to Artificial Neural Systems - Jacek M. Zurada, Jaico Publishing House, 1997.
3. Fuzzy logic with Fuzzy Applications – T.J Ross – McGraw Hill Inc, 1997.
4. Modern Power Electronics and AC Drives, Bimal K Bose, 1st Edition, Pearson Education, 2002

Reference Books:

1. Neural Networks, Fuzzy logic, Genetic algorithms: synthesis and applications by Rajasekharanand Pai – PHI Publication.
2. Introduction to Neural Networks using MATLAB 6.0 by S N Sivanandam, S Sumathi, S N Deepa TMGH
3. Introduction to Fuzzy Logic using MATLAB by S N Sivanandam, S Sumathi, S N Deepa Springer, 2007.

M.Tech. I-Semester

COURSE CODE – R2511XXYY	Renewable Energy Technologies (Program Elective – 1 & 2)	CATEGORY PE	L-T-P 3 -0-0	CREDITS 3
-----------------------------------	---	------------------------------	-------------------------------	----------------------------

Pre-requisite: Basics of Power Systems**Course Outcomes:** At the end of the course, student will be able to

		Knowledge Level (K)#
CO1	Explain the fundamentals of renewable energy sources, distributed generation, and grid integration, including economic and environmental aspects.	
CO2	Analyze different renewable energy systems such as wind, tidal, wave, photovoltaic, and fuel cells, including their design, performance characteristics, and MPPT/control techniques.	
CO3	Design and evaluate renewable energy systems and their integration strategies for practical applications, considering efficiency, reliability, and sustainability.	

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	3	2	2	2	2
CO2	3	2	3	3	3
CO3	3	2	3	3	3

(Please fill the above with Levels of Correlation, viz., 3: Strong, 2: Moderate, 1: Weak)

UNIT	CONTENTS	Contact Hours
UNIT – 1	Introduction: Renewable Sources of Energy; Distributed Generation; Renewable Energy Economics - Calculation of Electricity Generation Costs; Demand-Side Management Options; Supply-Side Management Options; Control of renewable energy-based power Systems; grid codes for synchronization, energy scenario in India and Abroad.	
UNIT – 2	Wind Power Plants: Site Selection; Evaluation of Wind Intensity; Topography; Purpose of the Energy Generation-Betz limit- General Classification of Wind Turbine - Generators and Speed Control Used in Wind Power Energy, Analysis of Small wind energy conversion system, MPPT schemes.	
UNIT – 3	Tidal Power: Power generation from barrages – Environmental considerations for tidal barrages – Integration of electrical power from tidal barrages – Tidal Lagoons – Tidal streams/currents Wave Energy: Physical Principles of Wave Energy - Wave Energy Technologies – Arrays – Environmental Impact – Integration.	
UNIT – 4	Photovoltaic Power Plants: Solar Energy; Generation of Electricity by Photovoltaic Effect; Dependence of a PV Cell on Temperature and irradiance input-output Characteristics - Equivalent Models and Parameters for Photovoltaic Panels; MPPT schemes: P&O, INC, effect of partial shaded condition. Applications of Photovoltaic Solar Energy-Economical Analysis of Solar Energy	
UNIT – 5	Fuel Cells: The Fuel Cell; Low- and High-Temperature Fuel Cells; Commercial and Manufacturing Issues - Constructional Features of Proton Exchange-Membrane Fuel Cells; Reformers; Electrolyzer Systems; Advantages and Disadvantages of Fuel Cells - Fuel Cell Equivalent Circuit; Practical Determination of the Equivalent Model Parameters; Aspects of Hydrogen for storage	
	Total	

Text Books:

1. Felix A. Farret, M. Godoy Simoes, Integration of Alternative Sources of Energy, John Wiley & Sons, 2006.
2. Stephen peake, Renewable Energy- Power for a Sustainable Future, Oxford Press,2018

Reference Books:

1. Gilbert M. Masters, Renewable and Efficient Electric Power Systems, John Wiley & Sons, 2004.
2. Remus Teodorescu, Marco Liserre, Pedro Rodríguez, Grid Converters for Photovoltaic and Wind Power Systems, John Wiley & Sons, 2011.

M.Tech. I-Semester

COURSE CODE – R2511XXYY	HVDC Transmission and Flexible AC Transmission Systems (Program Elective –1 & 2)	Category PE	L-T-P 3-0-0	Credits 3
--------------------------------	---	--------------------	--------------------	------------------

Pre-requisite: Knowledge on Power Electronics, Power Systems and High Voltage Engineering

Course Outcomes: At the end of the course, student will be able to,

		Knowledge Level (K)#
CO1	Explain the fundamentals of HVDC transmission systems, converters, DC link control, and the principles of FACTS devices and compensation techniques.	
CO2	Analyze HVDC converters, control strategies, harmonics, and the performance of FACTS devices such as SVC, STATCOM, TCSC, SSSC, and UPFC.	
CO3	Design and evaluate HVDC and FACTS-based solutions for power flow control, voltage regulation, and reactive power compensation in modern power systems.	

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	3	2	2	2	2
CO2	3	2	3	3	3
CO3	3	2	3	3	3

(Please fill the above with Levels of Correlation, viz., L, M, H)

UNIT	CONTENTS	Contact Hours
UNIT – 1	HVDC Transmission: DC Power Transmission: Need for power system interconnections, Evolution of AC and DC transmission systems, Comparison of HVDC and HVAC Transmission systems, Types of DC links, relative merits, Components of a HVDC system, Modern trends in DC Transmission systems.	
UNIT – 2	Analysis of HVDC Converters: Pulse number, choice of converter configurations, Analysis of Graetz circuit with and without overlap, voltage waveforms, Analysis of two and three valve conduction mode, Converter Bridge characteristics, Inverter mode of operation, voltage waveforms.	
UNIT – 3	HVDC Control: Principles of DC link control, Converter Control characteristics, Control hierarchy Constant current Control, CEA Control, firing angle control of valves, starting and stopping of a dc link, Power control, AC-DC power flow. Harmonics and Filters: effects of Harmonics, sources of harmonic generation, Types of filters –Design examples.	
UNIT – 4	Flexible AC Transmission Systems (FACTS): FACTS concepts and general system conditions: Power flow in AC systems, Relative importance of controllable parameters, Basic types of FACTS controllers, shunt and series controllers.	
UNIT – 5	Static Shunt Compensators: Objectives of shunt compensation, Methods of controllable VAR generation, Static Var Compensator, its characteristics, TCR, TSC, STATCOM, basic operating principle, control approaches and characteristics Static Series Compensators: Objectives of series compensator, variable impedance type of series compensators: TSSC & TCSC - SSSC. Introduction to Unified Power Flow Controller, Basic operating principles, Conventional control capabilities, Independent control of real and reactive power.	

	Total	
--	--------------	--

Text Books:

1. Narain G. Honarani, Laszlo Gyugyi: Understanding FACTS – Concepts and Technology of Flexible AC Transmission Systems, Wiley-IEEE Press, 2000.
2. K.R. Padiyar: HVDC Power Transmission Systems – Technology and System Interactions, New Age International Publishers, 2011.

Reference Books:

1. Kimbark: Direct Current Transmission, 1971.
2. Jos Arrillaga: High Voltage Direct Current Transmission, The Institution of electrical Engineers, 1998.
3. Yong Hua Song, Allan T Johns: Flexible AC Transmission Systems, The Institution of electrical Engineers, 1999.

M.Tech. I-Semester

COURSE CODE – R2511XXYY	Wide Band Gap Devices (Program Elective –1 & 2)	Category PE	L-T-P 3-0-0	Credits 3
-----------------------------------	--	------------------------------	------------------------------	----------------------------

Pre-requisite: Knowledge on Power Electronics, Power Systems and High Voltage Engineering

Course Outcomes: At the end of the course, student will be able to,

		Knowledge Level (K)#
CO1	Explain the fundamentals, static characteristics, and advantages of WBG devices (SiC MOSFET and GaN FET), including testing and characterization methods.	
CO2	Analyze gate drive requirements, PCB layout considerations, and device parasitics to optimize performance of GaN and SiC devices in power electronic circuits.	
CO3	Evaluate and compare power losses, efficiency, and switching performance of Si, SiC, and GaN devices in hard and soft switching converters for practical applications.	

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	2	1	3	1	2
CO2	2	1	3	3	3
CO3	1	2	3	3	3

(Please fill the above with Levels of Correlation, viz., L, M, H)

UNIT	CONTENTS	Contact Hours
UNIT – 1	Technology Overview: Wide Band Gap (WBG) Devices advantages-Comparison with Si, Current status, Basic Structure of SiC MoSFET, GaN FET, Fabrication of GaN Transistor Testing of WBG Devices: Pulsed I-V Testing, Curve Tracer, Temperature control for Device characterization	
UNIT – 2	Static Characteristics of SiC MoSFET and GaN FET devices: Output Characteristics, Transfer Characteristics, Gate current characteristics Device Parasitics -Miller ratio, Electrical Characteristics- Capacitance characteristics and reverse recovery charge- Calculation of C_{oss} related switching energies-Thermal resistance, Transient thermal impedance	
UNIT – 3	Gate Driver for GaN FET: Gate charge components, Gate drive requirements of Enhancement mode, Cascode FETs-Resonant Loop damping design, Bootstrapping and Floating Supplies, dv/dt immunity, di/dt immunity, Ground Bounce, Common mode current, Driving Cascode GaN Devices.	
UNIT – 4	PCB Lay out considerations for GaN FET: Board level Parasitics-Power loop inductance, Minimization of inductance, conventional techniques, PCB Layout considerations for paralleling GaN Transistor for Single switch-Half Bridge configuration. Modelling of GaN FET: Electrical Modeliling-Basic equivalent circuit modelling,-Limitations, Thermal Modelling- Electrically equivalent circuit thermal models	
UNIT – 5	Power Loss and Efficiency comparison: Hard switching loss analysis of SiC/GaN Transistor: Terminology associated with loss analysis, Switching losses-Miller charge- Gate charge, Coss loss, Reverse conduction loss, Reverse recovery loss, Conduction loss-	

	Buck converter example Soft switching loss analysis: ZVS, ZCS, Output charge- Gate charge-analysis from datasheet-Comparison between Si MoSFET, SiC MoSFET, GaN Transistor- Isolated full bridge resonant converter example.	
	Total	

Text Books:

1. A. Lidow, J. Strydom, M. D. Rooij, D. Reusch, "GaN Transistors for Efficient Power Conversion, Wiley, 2014, ISBN-13: 978-1118844762.
2. F. Wang, Z. Zhang and E. A. Jones, Characterization of Wide Bandgap Power Semiconductor Devices, IET, ISBN-13: 978-1785614910.
3. G. Meneghesso, M. Meneghini, E. Zanoni, "Gallium Nitride-enabled High Frequency and High Efficiency Power Conversion," Springer International Publishing, ISBN: 978-3-319-77993-5.
4. Ned Mohan, Tore M. Undeland, William P. Robbins, "Power Electronics," John Wiley & Sons, 2003

M.Tech. I-Semester

COURSE CODE – R2511XXYY	Power Converters Simulation Laboratory	CATEGORY Lab	L-T-P 0 -0-4	CREDITS 2
-----------------------------------	---	-------------------------------	-------------------------------	----------------------------

Course Outcomes: At the end of the course, student will be able to,

		Knowledge Level (K)#
CO1	Illustrate and simulate the switching characteristics, gate drive circuits, and performance of power semiconductor devices (MOSFET, IGBT, SCR) using PSPICE/LTSPICE.	
CO2	Design and simulate various power converter topologies including single-phase and three-phase inverters, rectifiers, and dual converters using different PWM techniques for voltage, current, and harmonic control.	
CO3	Analyze the power factor, harmonics, and efficiency of power electronic circuits and develop strategies to improve power quality and converter performance.	

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	3	2	3	2	2
CO2	2	2	3	3	3
CO3	2	2	3	3	3

(Please fill the above with Levels of Correlation, viz., L, M, H)

Any 10 of the following experiments are to be conducted.

List of Experiments:

1. Illustrate the switching characteristics of power MOSFET and power IGBT by using PSPICE/LTSPICE.
2. Illustrate the use of Driver circuit for power MOSFET and power IGBT by using PSPICE/LTSPICE.
3. Simulation of three phase full converter with RL & RLE loads.
4. Simulation of three-phase dual converter.
5. Simulation of single-phase full bridge inverter using unipolar & bipolar PWM techniques.
6. Simulation of three-phase two-level inverter for 120° & 180° mode of conduction.
7. Simulation of three phase two-level inverter using SPWM.
8. Simulation of three phase two-level inverter using Third Harmonic PWM,
9. Simulation of three phase two-level inverter using space vector PWM.
10. Simulation of three phase three-level NPC inverter using SPWM
11. Simulation of three phase five-level diode clamped inverter using SPWM
12. Simulation of Stair case modulation and SHE PWM for single-phase seven-level cascaded H-bridge inverter.
13. Simulation of Multicarrier PWM techniques for three-phase five-level cascaded H-bridge inverter.
14. Simulation of Modular Multilevel Converter.
15. PF and Harmonic analysis source side current of Three Rectifiers.
16. Boost PFC converters
17. SCR based PFC converters

M.Tech. I-Semester

COURSE CODE – R2511XXYY	Power Converters Laboratory	CATEGORY Lab	L-T-P 0-0-4	CREDITS 2
-----------------------------------	------------------------------------	-------------------------------	------------------------------	----------------------------

Course Outcomes: At the end of the course, student will be able to,

		Knowledge Level (K)#
CO1	Illustrate and analyze the switching characteristics and driver circuits of power semiconductor devices (MOSFET, IGBT) for various power electronics applications.	
CO2	Design and analyze DC-DC converters, AC-DC converters, and inverter topologies using different PWM techniques to control voltage, current, and power flow.	
CO3	Evaluate the performance of power electronic systems in terms of harmonics, modulation strategies, and multi-level converter operation to improve efficiency and power quality.	

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	3	2	3	2	2
CO2	2	2	3	3	3
CO3	2	2	3	3	3

(Please fill the above with Levels of Correlation, viz., L, M, H)

Any 10 of the following experiments are to be conducted.

List of Experiments:

1. Illustrate the switching characteristics of power MOSFET and power IGBT
2. Illustrate the use of Driver circuit for power MOSFET and power IGBT
3. Analysis of single phase full converter with RL & RLE loads.
4. Analysis of three phase full converter with RL & RLE loads.
5. Analysis of three-phase dual converter.
6. Analysis of Buck DC-DC converter.
7. Analysis of Boost DC-DC converter.
8. Analysis of Buck-Boost DC-DC converter.
9. Analysis of single-phase full bridge inverter using unipolar & bipolar PWM techniques.
10. Analysis of three-phase two-level inverter for 120° & 180° mode of conduction.
11. Analysis of three phase two-level inverter using SPWM.
12. Analysis of three phase two-level inverter using Third Harmonic PWM,
13. Analysis of three phase two-level inverter using space vector PWM.
14. Analysis of three phase three-level NPC inverter using SPWM
15. Analysis of three phase five-level diode clamped inverter using SPWM
16. Analysis of Stair case modulation and SHE PWM for single-phase seven-level cascaded H-bridge inverter.
17. Analysis of Multicarrier PWM techniques for three-phase five-level cascaded H-bridge inverter.
18. Analysis of Modular Multilevel Converter.

M.Tech. I-Semester

COURSE CODE –	TECHNICAL SEMINAR -I	CATEGORY	L-T-P 0 -0-2	CREDITS 1
----------------------	-----------------------------	-----------------	-------------------------	----------------------

Course Outcomes: At the end of the course, student will be able to

		Knowledge Level (K)#
CO1	Conduct an in depth literature survey on a chosen technical topic, analyze current trends, and identify research gaps.	3
CO2	Develop and present a coherent technical report and seminar presentation using appropriate tools, adhering to academic standards.	3
CO3	Demonstrate critical thinking, technical understanding, and effective communication skills through seminar discussions and defense of the work.	4

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	3	2	3	1	1
CO2	2	3	2	1	1
CO3	2	2	3	1	1

(Please fill the above with Levels of Correlation, viz., 3: Strong, 2: Moderate, 1: Weak)

M.Tech. II-Semester

COURSE CODE – R2512XXYY	Switched Mode Power Conversion (Program Core – 4)	Category PC	L-T-P 3-1-0	Credits 4
--------------------------------	--	--------------------	--------------------	------------------

Pre-requisite: Concepts of electrical circuit analysis and power electronics.

Course Outcomes: At the end of the course, student will be able to

		Knowledge Level (K)#
CO1	Explain the operation of non-isolated, isolated, and resonant DC-DC converters.	
CO2	Design power converter circuits with appropriate selection of components, magnetic designs, and control techniques.	
CO3	Develop averaged large signal, steady state and small signal mathematical models for controller design	

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	3	2	3	2	2
CO2	3	3	3	2	3
CO3	3	2	3	3	2

(Please fill the above with Levels of Correlation, viz., L, M, H)

UNIT	CONTENTS	Contact Hours
UNIT – 1	Non-isolated converters: Control of DC-DC converters: Buck converters, Boost converters, Buck-Boost converter, CUK Converter, continuous and discontinuous operation, Converter realization with non-ideal components.	
UNIT – 2	Isolated converters: Forwarded converter, forward converter with demagnetizing winding, flyback converter, push-pull converter, half-bridge converter, full bridge converter Voltage mode control, Current Mode Control, Peak current mode, current mode control instability, slope compensation, average current mode.	
UNIT – 3	Resonant converters: Basic resonant circuit concepts, series resonant circuits, parallel resonant circuits, phase modulated series resonant circuits, zero current switching quasi-resonant buck converter, zero current switching quasi-resonant boost converter, zero voltage switching quasi-resonant buck converter, zero voltage switching quasi-resonant boost converter, load resonant converter.	
UNIT – 4	Modeling of DC-DC converters: Steady state modeling of ideal and non-ideal converters, Circuit averaging method and average switch model technique to obtain averaged large signal model, small signal models of buck, boost, buck-boost converters, Derivation of converter transfer functions for buck, boost and buck-boost topologies.	
UNIT – 5	Design of Power Converters: Magnetic concepts - design of inductor, design of transformer, Selection of filter capacitors, Selection of ratings for devices, input filter design, Thermal design, Controller design using Bode approach.	
	Total	

Text Books:

1. Fundamentals of Power Electronics-Erickson, Robert W., Maksimovic, Dragan, Springer, 2011.
2. Power switching converters-Simon Ang, Alejandro Oliva, Press CRC, 2010.
3. Power Electronics: Essentials and applications- L. Umanand, Wiley publications

Reference Books:

1. Design of Magnetic Components for Switched Mode Power Converters- Umanand, S.P. Bhat, John Wiley& Sons Australia, 1992.
2. Switching Power Supply Design-Abraham I. Pressman, McGraw-Hill Ryerson, Limited, 1991.
3. Power Electronics – IssaBatareseh, Jhon Wiley publications, 2004.
4. Power Electronics: converters Applications & Design – Mohan, Undeland, Robbins-Wiley publications.

M.Tech. II-Semester

COURSE CODE – R2512XXYY	Power Electronic Control of Electrical Drives (Program Core – 5)	Category PC	L-T-P 4-0-0	Credits 4
-----------------------------------	--	-----------------------	-----------------------	---------------------

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

		Knowledge Level (K)#
CO1	Explain the principles, control strategies, and operating characteristics of induction motor, PMSM, BLDC, and SRM drives.	2
CO2	Apply vector control, direct torque control, and sensorless estimation techniques to operate AC motor drives under different speed and torque conditions.	3
CO3	Analyze motor drive dynamics, estimation algorithms, torque ripple minimization techniques, and design controllers for high-performance AC drives.	4

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	2	1	3	3	2
CO2	3	2	3	3	3
CO3	3	2	3	3	3

(Please fill the above with Levels of Correlation, viz., L, M, H)

UNIT	CONTENTS	Contact Hours
UNIT – 1	Vector Control of Induction Motor Drive: Open loop and closed loop V/f control, Principle of vector control – direct and indirect vector control, implementation of direct and indirect vector control, rotor field-oriented control, implementation of rotor field-oriented control, stator field-oriented control, field weakening control of induction motor.	
UNIT – 2	Sensor less Control of induction Motor Drive: Advantages of speed sensor less control, voltage current based speed sensor less control, MRAS-model reference adaptive systems, state equation of an induction motor, state observers, full-order observer, reduced order observer, Extended Kalman filter observers.	
UNIT – 3	Direct Torque Control of Induction Motor Drive: Principle of Direct torque control (DTC), concept of space vectors, DTC control strategy of induction motor, comparison between vector control and DTC, modified DTC of induction motor with constant switching frequency, space vector modulation based DTC of induction motors.	
UNIT – 4	Control of Permanent Magnet Synchronous Machines (PMSM) and Brushless DC (BLDC) Motor Drives: Advantages and limitations of Permanent magnet machines, operating principle of PMSM, vector control for PMSM, operating principle of BLDC, modeling of BLDC, similarities and difference between PMSM and BLDC, need for position sensing in BLDC motors, control strategies for PMSM and BLDC, methods of reducing torque ripples of BLDC motor.	
UNIT – 5	Control of Switched Reluctance Motor (SRM) Drive: SRM structure, Merits and limitations, stator excitation, converter topologies, SRM waveforms, Torque control schemes, speed control of SRM, torque ripple minimization, instantaneous -torque control using current controllers and flux controllers.	
	Total	

Text Books:

1. Bose B. K., "Power Electronics and Variable Frequency Drives", IEEE Press, Standard Publisher Distributors. 2001.
2. Kwang Hee Nam, "AC Motor Control and Electrical Vehicle Applications" Second Edition, CRC Press.

Reference Books:

1. Seung-Ki Sul, "Control of Electric Machine Drive Systems" IEEE Press, A John Wiley & Sons, Inc. Publications. 2011.
2. Krishnan R., "Electric Motor Drives – Modeling, Analysis and Control", Prentice Hall of India Private Limited.
3. Switched Reluctance Motors and Their Control-T. J. E. Miller, Magna Physics, 1993.
4. Power electronic converters applications and design-Mohan, Undeland, Robbins-Wiley publications.

M.Tech. II-Semester

COURSE CODE – R2512XXYY	Electric and Hybrid Electric Vehicles (Program Elective-6)	CATEGORY PE	L-T-P 3 -0-0	CREDITS 3
--------------------------------	---	--------------------	---------------------	------------------

Course Outcomes: At the end of the course, student will be able to

		Knowledge Level (K)#
CO1	Explain the fundamentals of conventional, electric, and hybrid vehicles, hybrid architectures, EV motor control, power-electronics used in HEVs/PHEVs, and battery/storage systems.	2
CO2	Apply EV/HEV fundamentals to configure hybrids, select drives, use converters, and choose storage systems.	4
CO3	Analyze EV/HEV technologies across powertrain, control, power-electronics, and energy-storage.	4

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	3	2	3	2	2
CO2	3		3	3	3
CO3	3	2	3	3	3

(Please fill the above with Levels of Correlation, viz., 3: Strong, 2: Moderate, 1: Weak)

UNIT	CONTENTS	Contact Hours
UNIT–1	Introduction: Fundamentals of vehicle, components of conventional vehicle and propulsion load; Drive cycles and drive terrain; Concept and classification of electric vehicle and hybrid electric vehicle; History of electric and hybrid vehicles, Comparison of conventional vehicle with electric and hybrid vehicles.	
UNIT–2	Hybridization of Automobile: Architectures of HEVs, series and parallel HEVs, complex HEVs. Plug-in hybrid vehicle, constituents of PHEV, comparison of HEV and PHEV; PHEV Architectures, equivalent electric range of blended PHEVs; Fuel economy of PHEVs, Extended range electric Vehicles (EREVs).	
UNIT–3	Motor Control in Electric Vehicles: Role of motors in Electric Vehicles, factors to choose motors for EV, Comparison of motors for EV power train, Motor Controller Unit (MCU)- need and components, Motor control units of two- and four –wheel EVs, Regenerative braking.	
UNIT–4	Power Electronics in HEVs: Power management of PHEVs, Rectifiers used in HEVs, PWM rectifier in HEVs, Voltage Source Inverters, Buck converter used in HEVs, non-isolated bidirectional DC-DC converter, isolated bidirectional DC-DC converter, PHEV battery charging, EV and PHEV battery chargers, vehicle-to-grid (V2G) and grid-to-vehicle (G2V) technology.	
UNIT–5	Battery and Storage Systems Types of batteries: Lead–Acid Batteries, Nickel-Metal batteries, Lithium-Ion Batteries (Li-ion), Battery management systems; end-of-life batteries for electric power grid support; Ultra capacitors; Fuel Cells vehicles and its constituents, Superconducting Magnetic Storage System; Compressed Air Energy Storage.	
Total		48 Hrs

Text Books

1. Ali Emadi, Advanced Electric Drive Vehicles, CRC Press, 2014.

2. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.

Reference Books:

1. Mehrdad Ehsani, YimiGao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.
2. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003.
3. H. Partab: Modern Electric Traction - DhanpatRai& Co, 2007.
4. Symo and farad text book

ResearchBooks:

1. Pistooa G., “Power Sources , Models, Sustanability, Infrstructure and the market”, Elsevier 2008
2. Mi Chris, Masrur A., and Gao D.W., “ Hybrid Electric Vehicle: Principles and Applications with Practical Perspectives” 1995.

M.Tech. II-Semester

COURSE CODE – R2512XXYY	Power Converters for Micro Grid (Program Elective – 3 & 4)	Category PE	L-T-P 3-0-0	Credits 3
-----------------------------------	--	-----------------------	-----------------------	---------------------

Course Outcomes: At the end of the course, student will be able to

		Knowledge Level (K)#
CO1	Explain international & Indian grid codes, synchronization principles, modulation techniques, converter modes, and grid requirements for renewable systems.	2
CO2	Apply control, synchronization, and modulation methods to operate grid-connected converters and renewable energy systems under balanced and unbalanced grid conditions.	3
CO3	Analyze grid interaction challenges, power quality issues, microgrid control strategies, and fault/abnormal-condition behavior of renewable energy systems to ensure stable grid operation.	4

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	2	1	3	3	2
CO2	3	2	3	3	3
CO3	3	2	3	3	2

(Please fill the above with Levels of Correlation, viz., L, M, H)

UNIT	CONTENTS	Contact Hours
UNIT – 1	International regulations, response to abnormal grid conditions (voltage deviations, frequency deviations), power quality issues on DC current injection, current harmonics, power factor. Indian Regulations, Renewable energy scenario, Variability and scheduling, CREC Regulations.	
UNIT – 2	Grid synchronization with PV and wind turbine systems, Analysis of AC signals-Clarks Transformation-Parks Transformation-Real and Reactive power reference generation, voltage vector under normal and abnormal grid conditions, synchronous reference frame PLL under unbalanced and distorted grid conditions, Different PLL techniques.	
UNIT – 3	Overview of Modulation Techniques for PWM control-SPWM-SVPWM, Control of Inverters-Filter structure and design- State feedback PWM Voltage control- SV PWM, Sliding mode control. Overview of control techniques for grid connected converters for unbalanced current injection, power control under unbalanced grid condition, flexible power control with current limitation.	
UNIT – 4	Microgrid: Operating modes of converter, Grid forming converters- PI-Control in dq domain, Grid Feeding Converters, Grid Supporting converters for Islanded operation-Active and Reactive power-Resistive-Inductive grid-Virtual Impedance-Angle droop control, DC Microgrid-P-V droop control	
UNIT – 5	Wind power development, Grid requirements for wind turbine systems, grid code evolution, frequency and voltage deviation under normal operation, active and reactive power control in normal operation, behavior under grid disturbance.	
	Total	

Text Books:

1. Arindam Ghosh, Firuz zare, “Control Power Electronics with Micro Grid Applications”, IEEE Press Wiley,2023

2. Integration of Alternative sources of Energy, Felix A. Farret and M. Godoy Simoes, IEEE Press – Wiley-Interscience publication, 2006.
3. Amirnaser Yazdani; Reza Iravani, “Voltage-Sourced Converters in Power Systems: Modeling, Control, and Applications”, Wiley-IEEE Press, 2010.
4. Grid integration of solar photovoltaic systems, Majid Jamil, M. Rizwan, D.P.Kothari, CRC Press (Taylor & Francis group), 2017

M.Tech. II-Semester

COURSE CODE – R2512XXYY	Battery Management Systems and Charging Stations (Program Elective – 3 & 4)	CATEGORY PE	L-T-P 3 -0-0	CREDITS 3
------------------------------------	--	------------------------	-------------------------	----------------------

Course Outcomes: At the end of the course, student will be able to

		Knowledge Level (K)#
CO1	Explain different EV battery types, their nominal ratings, and key characteristics, and apply appropriate charging and balancing strategies to ensure safety, efficiency, and extended battery life.	2
CO2	Analyze and design battery management system (BMS) architecture, including components, communication protocols, and charging infrastructure integration for robust EV operation.	3
CO3	Evaluate battery modeling, diagnostics, and real-world operational challenges to enhance EV performance, reliability, and safety under diverse application conditions.	4

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	3	2	3	2	2
CO2	3	3	3	2	2
CO3	3	2	3	2	1

(Please fill the above with Levels of Correlation, viz., 3: Strong, 2: Moderate, 1: Weak)

UNIT	CONTENTS	Contact Hours
UNIT – 1	EV Batteries: Cell and battery fundamentals – nominal voltage, capacity, C-rate, energy and power relationships; series and parallel cell configurations. Lead–Acid Batteries: Basic operation, characteristics, life cycle, and maintenance. Nickel-Based Batteries: Ni-Cd and Ni-MH batteries – chemistry and applications. Sodium-Based Batteries: Na–S and Na–NiCl ₂ (Zebra) batteries. Lithium-Based Batteries: Li-ion and Li-polymer batteries – structure, chemistry, and characteristics.	
UNIT – 2	Battery Charging Strategies: Charging algorithms – CC, CV, CC–CV, MSCC, TSCC, CVCC–CV, and pulse charging methods for different chemistries (Lead–acid, NiMH, Li-ion); charging performance evaluation, termination techniques, and emerging fast-charging technologies. Battery Balancing Techniques: Sorting, overcharge balancing, passive and active balancing methods.	
UNIT – 3	Charging Infrastructure: Overview of domestic and public charging infrastructure; classification – normal, fast, occasional, and battery-swapping stations; AC/DC chargers and communication standards (IEC 61851, ISO 15118); grid interaction, move-and-charge zones, and safety protocols.	
UNIT – 4	Battery Management System (BMS): BMS architecture and design requirements; sensing (voltage, current, temperature, isolation); contactor and thermal control; protection and diagnostics; SOC, SOH,	

	SOE estimation; communication interfaces (CAN, LIN); charger control and data logging.	
UNIT – 5	Battery Modeling and Simulation: Overview of modeling approaches; equivalent circuit and electrochemical models; Li-ion and NiCd battery simulation; model parameterization and validation; diagnostic methods for degradation analysis; case studies of model-based BMS implementation.	
	Total	48 Hrs

Text Books

1. James Larminie and John Lowry, Electric Vehicle Technology Explained, Oxford University Press. (Unit–1)
2. K. T. Chau, Energy Systems for Electric and Hybrid Vehicles, IET Publications, 1st Edition, 2016. (Unit–2)

Reference Books:

1. C. C. Chan and K. T. Chau, Modern Electric Vehicle Technology, Oxford University Press, New York, 2001. (Unit–3)
2. Gregory L. Plett, Battery Management Systems, Vol. II: Equivalent Circuits and Methods, Artech House Publishers, 1st Edition, 2016. (Unit–4)
3. Henk Jan Bergveld, Wanda S. Kruijt, and Peter H. L. Notten, Battery Management Systems: Design by Modelling, Springer Science & Business Media, 2002. (Unit–5)

M.Tech. II-Semester

COURSE CODE – R2512XXYY	Advanced Digital Signal Processing (Program Elective – 3 & 4)	Category PE	L-T-P 3-0-0	Credits 3
-----------------------------------	---	-----------------------	-----------------------	---------------------

Course Outcomes: At the end of the course, student will be able to

		Knowledge Level (K)#
CO1	Summarize digital filter structures, design considerations, and DSP computation principles for signal processing applications.	2
CO2	Construct IIR and FIR digital filters using classical and optimization-based methods and implement DSP algorithms for practical computation.	3
CO3	Analyze finite word-length effects, computational constraints, and spectral estimation techniques to evaluate DSP system performance.	4

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	2	1	3	2	1
CO2	3	2	3	2	1
CO3	3	2	3	2	1

(Please fill the above with Levels of Correlation, viz., L, M, H)

UNIT	CONTENTS	Contact Hours
UNIT – 1	Digital Filter Structure: Block diagram representation-Equivalent Structures-FIR and IIR digital filter Structures All pass Filters-tunable IIR Digital Filters-IIR tapped cascaded Lattice Structures-FIR cascaded Lattice structures-Parallel-Digital Sine-cosine generator-Computational complexity of digital filter structures.	
UNIT – 2	Digital filter design: Preliminary considerations-Bilinear transformation method of IIR filter design-design of lowpass, high pass-band pass, and band stop- IIR digital filters-Spectral transformations of IIR filters, FIR filter design-based on windowed Fourier series- design of FIR digital filters with least –mean- square-error-constrained least-square design of FIR digital filters	
UNIT – 3	DSP algorithm implementation: Computation of the discrete Fourier transform- number representation-arithmetic operations handling of overflow-tunable digital filters-function approximation.	
UNIT – 4	Analysis of finite Word length effects: The quantization process and errors- quantization of fixed -point and floating -point Numbers-Analysis of coefficient quantization effects, Analysis of arithmetic round-off errors, dynamic range scaling-signal- to- noise ratio in low -order IIR filters-low-sensitivity digital filters-Reduction of Product round-off errors using error feedback-Limit cycles in IIR digital filters, Round-off errors in FFT Algorithms.	
UNIT – 5	Power Spectrum Estimation: Estimation of spectra from finite duration observations signals – Non-parametric methods for power spectrum estimation – parametric method for power spectrum estimation, estimation of spectral form-finite duration observation of signals-non-parametric methods for power spectrum estimation-Walsh methods-Blackman & torchy method.	
	Total	

Text Books:

1. Digital signal processing-Sanjit K. Mitra-TMH second edition, 2002.
2. Discrete Time Signal Processing – Alan V.Oppenheim, Ronald W.Shafer - PHI-1996 1st

edition-9th reprint

Reference Books:

1. Digital Signal Processing and principles, algorithms and Applications – John G.Proakis -PHI – 3rd edition-2002.
2. Digital Signal Processing – S.Salivahanan, A.Vallavaraj, C. Gnanapriya – TMH - 2nd reprint- 2001
3. Theory and Applications of Digital Signal Proceesing-LourensR. Rebinar&Bernold.
4. Digital Filter Analysis and Design-Auntonian-TMH.

M.Tech. II-Semester

COURSE CODE – R2512XXYY	Applications of Power Converters (Program Elective – 3 & 4)	Category PE	L-T-P 3-0-0	Credits 3
-----------------------------------	---	-----------------------	-----------------------	---------------------

Course Outcomes: At the end of the course, the student will be able to

		Knowledge Level (K)#
CO1	Describe the operating principles and functional requirements of power electronic converters used in induction heating, lighting, renewable-based systems, high-voltage applications, and UPS/filter systems.	2
CO2	Design and configure suitable converter topologies for heating, lighting, pumping, electric traction, and bidirectional power flow applications.	3
CO3	Evaluate performance, efficiency, and power-quality characteristics of practical power converter systems including HV supplies, LED drivers, EV charging interfaces, UPS, and active power filters.	4

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	2	1	3	2	3
CO2	3	2	3	3	3
CO3	3	2	3	2	3

(Please fill the above with Levels of Correlation, viz., L, M, H)

UNIT	CONTENTS	Contact Hours
UNIT – 1	Inverters for Induction Heating: For induction cooking, induction hardening, melting, and welding applications.	
UNIT – 2	Power Converters for Lighting, pumping and refrigeration Systems: Electronic ballast, LED power drivers for indoor and outdoor applications. PFC based grid fed LED drivers, PV / battery fed LED drivers. PV fed power supplies for pumping/refrigeration applications.	
UNIT – 3	High Voltage Power Supplies - Power supplies for X-ray applications - power supplies for radar applications - power supplies for space applications. Low voltage high current power supplies: Power converters for modern microprocessor and computer loads	
UNIT – 4	Bi-directional DC-DC (BDC) converters: Electric traction, automotive Electronics and charge/discharge applications, Line Conditioners and Solar Charge Controllers	
UNIT – 5	Power Conditioners: Uninterrupted Power Supplies - Active Power Filters - Shunt active power filters - Series active power filters - Hybrid active power filters - UPQC	
	Total	

Text Books:

1. Ali Emadi, A. Nasiri, and S. B. Bekiarov: Uninterruptible Power Supplies and Active Filters, CRC Press, 2005.
2. M. Ehsani, Y. Gao, E. G. Sebastien and A. Emadi: Modern Electric, Hybrid Electric and Fuel Cell Vehicles, 1st Edition, CRC Press, 2004.

References Books:

1. William Ribbens: Understanding Automotive Electronics, Newnes, 2003.

M.Tech. II-Semester

COURSE CODE – R2512XXYY	Digital Control Systems (Program Elective – 3 & 4)	CATEGORY PE	L-T-P 3-0- 0	CREDITS 3
------------------------------------	---	------------------------	-----------------------------	----------------------

Course Outcomes: At the end of the course, student will be able to

		Knowledge Level (K)#
CO1	Interpret digital control system fundamentals, sampling mechanisms, Z-transform tools, and discrete-time stability principles.	2
CO2	Develop state-space models for digital systems, perform system discretization, and implement controllability/observability evaluations and pole-placement-based controllers.	3
CO3	Examine discrete-time system stability, evaluate observer structures, and compare closed-loop performance for advanced digital control designs.	4

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	2	1	3	3	1
CO2	3	2	3	3	1
CO3	3	2	3	3	1

(Please fill the above with Levels of Correlation, viz., L, M, H)

UNIT	CONTENTS	Contact Hours
UNIT – 1	Introduction Introduction to analog and digital control systems – Advantages of digital systems – Typical examples– Sample and hold devices – Sampling theorem and data reconstruction-Transfer functions and frequency domain characteristics of zero order hold and first order hold. Review of Z–transforms and Inverse Z–transforms- solving differential equations. Mapping between the S–Plane and the Z–Plane – Primary strips and Complementary Strips.	
UNIT – 2	State space analysis and the concepts of Controllability and observability State Space Representation of discrete time systems – State transition matrix properties and evaluation – Solution of state equations- Discretization of continuous-time state equations –controllability and observability – concepts, conditions and tests, Principle of duality.	
UNIT – 3	Stability Analysis Stability criterion – Modified Routh’s stability criterion and Jury’s stability test, Lyapunov’s stability analysis, Root locus technique in the z–plane.	
UNIT – 4	State feedback controller design Design of state feedback controller through pole placement techniques, Necessary and sufficient conditions, Ackermann’s formula, controller for deadbeat response, control system with reference input.	
UNIT – 5	State Observer Necessary and sufficient condition for state observation-Full order state observer- error dynamics – design of prediction observers- Ackermann’s formula-effect of the addition of observer on closed loop system-Current observer- minimum order observer observed – state feedback control system with minimum order observer -control system with reference input.	
	Total	

Text Book:

1. Discrete–Time Control systems – K. Ogata, Pearson Education/PHI, 2nd Edition.
2. B. C. Kuo, “Digital control systems”- Holt Saunder’s International Edition, 1991.

Reference Books:

1. M. Gopal: Digital control engineering, New Age Int. Ltd., India, 1998.
2. K. Ogata, “Modern control engineering”- PHI, 1991.

M.Tech. II-Semester

COURSE CODE – R2512XXYY	Industrial Internet of Things (Program Elective – 3 & 4)	Category PE	L-T- P 3-0-0	Credits 3
------------------------------------	---	------------------------	-----------------------------	----------------------

Course Outcomes: At the end of the course, the student will be able to

		Knowledge Level (K)#
CO1	Describe IoT communication protocols, sensing/actuation principles, and networking fundamentals for smart devices and industrial systems.	2
CO2	Develop IoT-based applications using Arduino, Raspberry Pi, and embedded platforms for domestic and industrial appliances.	3
CO3	Evaluate IoT cloud/fog architectures, smart device integration, and data analytics to design scalable and secure IoT systems for industrial, domestic, and smart city applications.	4

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	2	1	3	1	1
CO2	3	2	3	1	1
CO3	3	2	3	1	1

(Please fill the above with Levels of Correlation, viz., L, M, H)

UNIT	CONTENTS	Contact Hours
UNIT – 1	IoT Communication Technologies: Introduction to IoT, Sensing, Actuation, Basics of Networking, Communication Protocols, Sensor Networks, Machine-to-Machine Communications. Interoperability in IoT.	
UNIT – 2	IoT Control Technologies and Programming: Introduction to Arduino Programming, Integration of Sensors and Actuators with Arduino, Internet of Things Open-Source Systems. Introduction to Python programming, Introduction to Raspberry. Implementation of IoT with Raspberry Pi, Smart Grid Hardware Security.	
UNIT – 3	Domestic Appliances: Solid State Lamps: Introduction - Review of Light sources - white light generation techniques-Characterization of LEDs for illumination application. Power LEDs - High brightness LEDs - Electrical and optical properties. LED driver considerations-Power management topologies -color issues of white LEDs- Dimming of LED sources.	
UNIT – 4	Industrial Appliances: BLDC motors for pumping and domestic fan appliances, inverter technology-based home appliances, Smart devices and equipment. Industrial IoT applications Factories and Assembly Line- Power Plants, Plant Safety and Security (Including AR and VR safety applications)- Oil and chemical Industry- Applications of UAVs in Industries.	
UNIT – 5	IoT Cloud Computation and Applications: Introduction to SDN. SDN for IoT, Data Handling and Analytics, Cloud Computing, Sensor- Cloud. Fog Computing, Smart Cities and Smart Homes, Electric Vehicles, Industrial IoT, Case Study: Agriculture, Healthcare, Activity Monitoring, Role of ML and AI in IoT.	
	Total	

Text Books:

1. Sudip Misra, Chandana Roy, Anandarup Mukherjee, Introduction to Industrial Internet of Things and Industry 4.0, CRC press, 2021.

2. Kostas Siozios, Dimitrios Anagnostos, Dimitrios Soudris, Elias Kosmatopoulos, IoT for Smart Grids: Design Challenges and Paradigms, Springer publishers, 2019.
3. Vinod Kumar Khanna, Fundamentals of Solid-State Lighting: LEDs, OLEDs, and Their Applications in Illumination and Displays, CRC press, 2014, 1st Edition.

Reference Books:

1. Alasdair Gilchrist, Industry 4.0: The Industrial Internet of Things, Apress Publishers, 2016.
2. Craig Di Louie, Advanced Lighting Controls: Energy Savings, Productivity, Technology and Applications, River publishers, 2006, e-book, 2021, 1st Edition.
3. Chang-liang Xia, Permanent Magnet Brushless DC Motor Drives and Controls, John Wiley & Sons Singapore Pte. Ltd., 2012, 1st Edition.

Other Suggested Readings:

1. <https://nptel.ac.in/courses/106105166>

M.Tech. II-Semester

COURSE CODE – R2512XXYY	EV s and Battery Technologies lab (Laboratory – 3)	Category Lab	L-T-P 0-1-2	Credits 2
-----------------------------------	--	-------------------------------	------------------------------	----------------------------

Course Objectives: At the end of the course, the student will be able to

		Knowledge Level (K)#
CO1	Describe the performance characteristics of PMSM, BLDC, and Induction Motors under variable load conditions, including efficiency, torque, and power for EV drive cycles.	2
CO2	Implement motor control strategies such as vector control, V/F control, and regenerative braking in MATLAB/Simulink, and demonstrate battery charging/discharging and cell balancing techniques.	3
CO3	Analyze Battery Management Systems (BMS), CAN-based microcontroller communication, and converter-based charging systems to evaluate safety, reliability, and energy management in EVs.	4

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	2	1	3	2	2
CO2	3	2	3	3	3
CO3	3	2	3	2	3

(Please fill the above with Levels of Correlation, viz., L, M, H)

Any 10 of the following experiments are to be conducted.

List of Experiments:

- Performance analysis of Permanent Magnet Synchronous Motor fed Electric Vehicle under varying loading conditions
 - Computation of operating points with Maximum efficiency
 - Constant torque and Constant Power operation
- Charging and Discharging characteristics of Li-Fe Po₄ Battery pack
- Performance analysis of BLDC motor fed Electric Vehicle for variable load conditions
- Communication between Micro controller and STM32 using CAN interface- Battery health Monitoring
- Study of BMS systems (3s40A/30A/20A/BQ Series boards) for Li-Ion battery pack
 - Cell voltage monitoring
 - Passive cell balancing
 - Short circuit/Over current/Over voltage/Under voltage protection
- Control of PMSM for one complete EV cycle
 - Involves PI controller based vector control with 2 level inverter in Matlab/Simulink
- Control of BLDC motor for one complete EV cycle
 - Involves PI controller based vector control in Matlab Simulink
- Control of IM for One complete EV cycle
 - Involves V/F control in Matlab Simulink
- Realization of Regenerative braking in DC/PMSM/ IM/BLDC machines using converters in Simulation
- Passive and Active cell balancing of Li-ion battery pack in Simulation
- Phase shift Modulated Dual Active/Isolated Full bridge converters for charging in simulation
- Characterization of Power, Torque, Efficiency for one complete EV drive cycle in simulation

M.Tech. II-Semester

COURSE CODE – R2512XXYY	Digital Controllers and Electric Drives Laboratory (Laboratory – 4)	Category	L-T-P 0-1-2	Credits 2
------------------------------------	--	-----------------	------------------------	----------------------

Course Outcome: At the end of the course, the student will be able to

		Knowledge Level (K)#
CO1	Describe interfacing techniques, PWM generation methods, and field-oriented control principles for induction, PMSM, BLDC, and SRM drives.	2
CO2	Implement open-loop and closed-loop motor control strategies, including V/f control, vector control, direct torque control, SPWM, and SVM-based methods using C2xx controllers and simulation platforms.	3
CO3	Analyze the performance of induction, PMSM, BLDC, and SRM drives, including speed control, torque response, field weakening, and observer-based estimation techniques.	4

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	1	2	3	3	2
CO2	2	1	3	3	3
CO3	3	2	3	3	2

(Please fill the above with Levels of Correlation, viz., L, M, H)

Any 10 of the following experiments are to be conducted.

List of experiments:

1. Interfacing of ADC/DAC with C2xx Series controller
2. PWM generation using basic timer with C2xx Series controller
3. Generation of SPWM pulses with soft start using C2xx Series controller
4. Speed control of induction motor in open loop and closed loop using V/f method
5. Indirect vector control of induction motor with rotor field-oriented scheme.
6. Direct vector control of induction motor with rotor field-oriented scheme.
7. Field weakening control for vector control of induction motor.
8. MRAS based speed estimation for vector control of induction motor.
9. Switching table based direct torque control of induction motor.
10. Space vector modulation based direct torque control of induction motor.
11. Vector control of permanent magnet synchronous motor.
12. Speed control of brushless DC motor drive
13. Speed control of switched reluctance motor drive.
14. Simulation of brushless DC motor drive using the Hall effect sensor for speed control.
15. Simulation of switched reluctance motor drive for speed control.

M.Tech. II-Semester

COURSE CODE – R2512XXYY	Technical Seminar – II	PC	L-T- P 0-0-2	Credits 1
------------------------------------	-------------------------------	-----------	-----------------------------	----------------------

Course Outcomes: At the end of the course, student will be able to

		Knowledge Level (K)#
CO1	Conduct an in depth literature survey on a chosen technical topic, analyze current trends, and identify research gaps.	3
CO2	Develop and present a coherent technical report and seminar presentation using appropriate tools, adhering to academic standards.	3
CO3	Demonstrate critical thinking, technical understanding, and effective communication skills through seminar discussions and defense of the work.	4

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	3	2	3	1	1
CO2	2	3	2	1	1
CO3	2	2	3	1	1

(Please fill the above with Levels of Correlation, viz., 3: Strong, 2: Moderate, 1: Weak)

M.Tech. II-Semester

COURSE CODE – R2521XXYY	Research Methodology and IPR	Category	L-T-P 3-0-0	Credits 3
-----------------------------------	-------------------------------------	-----------------	-----------------------	---------------------

M.Tech. III-Semester

COURSE CODE – R2521XXYY	Summer Internship/ Industrial Training (8-10 weeks)	CATEGORY	L-T-P	CREDITS 3
-----------------------------------	--	-----------------	--------------	---------------------

Course Outcomes: At the end of the course, student will be able to

		Knowledge Level (K)#
CO1	Apply engineering concepts and problem-solving skills to practical challenges encountered during industry exposure.	3
CO2	Develop technical and professional skills through hands-on experience in an industrial environment.	4
CO3	Communicate effectively by documenting and presenting technical work and collaborating professionally in a team setting.	5

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	3	--	2	2	2
CO2	3	--	2	2	2
CO3	1	3	1	--	--

(Please fill the above with Levels of Correlation, viz., 3: Strong, 2: Moderate, 1: Weak)

M.Tech. III-Semester

COURSE CODE – R2521XXYY	Comprehensive Viva	CATEGORY	L-T-P	CREDITS 2
------------------------------------	---------------------------	-----------------	--------------	----------------------

Course Outcomes: At the end of the course, student will be able to

		Knowledge Level (K)#
CO1	Demonstrate comprehensive understanding and clarity in responding to technical questions during oral communication.	3
CO2	Analyze and synthesize information to critically discuss a specific engineering topic, integrating interdisciplinary concepts.	4
CO3	Communicate technical ideas clearly and professionally, exhibiting ethical standards and confidence during oral examination.	5

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	2	--	3	1	1
CO2	3	--	3	2	2
CO3	2	3	2	--	--

(Please fill the above with Levels of Correlation, viz., 3: Strong, 2: Moderate, 1: Weak)

M.Tech. III & IV-Semester

COURSE CODE – R2521XXYY	DISSERTATION-PART A&B	CATEGORY PJ	L-T-P 0-0-52	CREDITS 26
------------------------------------	----------------------------------	------------------------	-------------------------	-----------------------

Course Outcomes: At the end of the course, student will be able to

		Knowledge Level (K)#
CO1	Identify and define a significant engineering problem through critical literature review and domain analysis, aligned with current technological or industrial needs.	4
CO2	Develop and apply advanced modeling, simulation, and experimental methods to design and validate effective engineering solutions.	6
CO3	Prepare and present technical documentation and research findings effectively, demonstrating academic integrity, ethical conduct, and professionalism.	5

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	3	--	3	2	2
CO2	3	--	3	3	3
CO3	2	3	2	1	1

(Please fill the above with Levels of Correlation, viz., 3: Strong, 2: Moderate, 1: Weak)