KL Electrical & Electronics Engineering

KLEF
DEPARTMENT OF ELECTRICAL ENGINEERING
PROGRAM DEVELOPMENT DOCUMENT
M.Tech in ELECTRIC VEHICLE TECHNOLOGY
2022

Vision of the University

To be a globally renowned university.

Mission of the university:

To impart quality higher education and to undertake research and extension with emphasis on application and innovation that cater to the emerging societal needs through all-round development of students of all sections enabling them to be globally competitive and socially responsible citizens with intrinsic values.

VISION of the Department

To Produce globally renowned leader in education, extension activities and Carrying out research and technology development in frontier areas of electronics and electrical engineering and allied fields

MISSION of the Department

To produce quality electrical and electronics engineers having strong theoretical foundation, innovative, good design experience , exposure to research and development and responsible for social needs.

Program Educational Objectives

Programme Educational Objectives:
1.To produce well trained post graduates in the domain of power electronics and electrical drives, and ensure that at least 50 % of those are employable in the diversified sectors of industry, public sector or multinational corporations.
2. To produce some of these (15-20 %) post graduates will pursue Ph.D.
3. To produce some of these will demonstrate the academic leadership in engineering institutions and serve the education.
4. To inculcate research attitude and lifelong learning among postgraduates

Program Outcomes

a. apply the knowledge of science and mathematics in designing, analyzing and using the power converters and drives for various applications and problem solving
b. design the modern electric machines, drives, power converters, and control circuits for specific application
c. use modern tools, professional software platforms, embedded systems for the diversified applications
d. Function as a member of a multidisciplinary team and correlate the domain knowledge with global problems.
e. sense and demonstrates the communication at different levels effectively
f. explore ideas for inculcating research skills and appreciate, critical and independent thinking and engage in lifelong learning

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MAPPING OF PEOs with MISSION OF THE DEPARTMENT:

S.No.	Program Educational Objectives(PEOs)	M1 Training the leaders of tomorrow	M2 Training the innovators of tomorrow	M3 Training the outstanding career professionals of tomorrow	M4 Conducting fundamental research
1	To produce well trained post graduates in the domain of power electronics drives, and ensure that at least 50 % of those are employable in the diversified sectors of industry, public sector or multinational corporations.	√	√	√	
2	To produce some of these (15-20 %) post graduates will pursue Ph.D.		√	√	√
3	To produce some of these will demonstrate the academic leadership in engineering institutions and serve the education.	√	√	√	
4	To inculcate research attitude and lifelong learning among postgraduates		√	√	√

MAPPING OF POs/PSOs with PEOs:

Mapping of POs to PEOs					
S.No.	Program Objectives(POs)	Program Educational Objectives(PEOs)			
		1	2	3	4
a	apply the knowledge of science and mathematics in designing, analyzing and using the power converters and drives for various applications and problem solving	√	√	√	√
b	.design the modern electric machines, drives, power converters, and control circuits for specific application	√	√		√
c	use modern tools, professional software platforms, embedded systems for the diversified applications	√	√		√
d	Function as a member of a multidisciplinary team and correlate the domain knowledge with global problems.	√	√	√	√
e	sense and demonstrates the communication at different levels effectively	√		√	√
f	explore ideas for inculcating research skills and appreciate, critical and independent thinking and engage in lifelong learning	√	√		√

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MAPPING OF COURSE OUTCOMES WITH PROGRAM OUTCOMES (POs) and PROGRAM SPECIFIC OUTCOMES (PSOs)

				PO						PSO	
Course Code	Course Title	CO NO	Description of the Course Outcome	1	2	3	4	5	6	1	2
22EE5101	ELECTRIC VEHICLE POWER TRAIN DESIGN	CO1	Understand the History, Economics, Environmental issues and power train of Electric Vehicles					3			
		CO2	Analyze the dynamics of EV		3						
		CO3	Select and size the power train for 2W	3							
		CO4	Select and size the power train for 4W	3							
22EE5102	BATTERY MODELLING AND STATE ESTIMATION	CO1	Understand the specifications and Li-ion chemistry	3							
		CO2	Understand the key functions of Battery management systems	3							
		CO3	Develop Enhanced Self Correcting (ESC) Model of battery						3		
		CO4	Develop Algorithms for SOC estimation of battery					3			
		CO5	Analyse Modelling and state estimation through experimental techniques			3					
22EE5103	MECHANICAL DESIGN OF VEHICLE	CO1	Identify different car body and body materials.	3							
		CO2	Identify design features of frame, front axle, and steering system		3						
		CO3	Model Suspension and Wheel system for vehicle	3							
		CO4	Model the braking system for vehicle		3						
22EE5104	EMBEDDED CONTROLLERS AND APPLICATIONS	CO1	Apply Programming of 8051 Microcontroller for general purpose applications			3					
		CO2	Apply programming concepts of 8051 for interfacing peripherals			3					
		CO3	Demonstrate Architecture and Programming of PIC Microcontoller			3					
		CO4	Apply programming concepts of 8051 and PIC Microcontroller for interfacing peripherals			3					
		CO5	Apply programming concepts of the 8051and PIC microcontroller					3			
22EE5211	ADVANCED ELECTRICAL DRIVES	CO1	Understand the modeling of AC machines	3	2						
		CO2	Contrast the speed control performance of 3-Phase induction and synchronous motor drive using vector control methods	3	2						
		CO3	Analyze the dynamic behavior of SRM motor drives under various control methods	3	2						
		CO4	Distinguish the performance of BLDC Motor drive using various control techniques	3	2						

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		CO5	Demonstrate and test electric converters by hardware realization and MATLAB software		3						
22EE5202	FAULT DIAGNOSIS & CONTROL OF ELECTRIC VEHICLE	CO1	Apply characteristics of sensors and actuators used for electric vehicle control	3		2			3		2
		CO2	Apply usage of microcontroller for digital control of electric vehicle	3				2	3		
		CO3	Apply communication protocols for data communication in electric vehicle control system					3			
		CO4	Model fault diagnosis system for electric vehicle					3			
22EE5203	CHARGING STATION DESIGN	CO1	Interpret Power electronic converters for electric vehicle charging	3	2						
		CO2	Develop control algorithms for various electric vehicle charging modes	3		2					
		CO3	Demonstrate charging station infrastructure	3					2		
		CO4	Demonstrate installation of charging station	3							
22EE5204	AI AND IOT FOR MODERN ELECTRICAL SYSTEMS	CO1	Demonstrate IoT devices and tools				3				
		CO2	Operate the cloud system Environment				3				
		CO3	Utilize AI and ML Techniques		3						
		CO4	Utilize AI techniques for electrical systems						3		
22EE51A1	RELIABILITY ENGINEERING	CO1	Understand the system reliability concepts	3							
		CO2	Apply the frequency and duration techniques for component repairable system.	3							
		CO3	Apply the network reliability concepts to generation system reliability analysis.	3							
		CO4	Apply the network reliability concepts to transmission and distribution system reliability analysis.	3							
22EE51A2	APPLICATION OF PYTHON PROGRAMMING IN ELECTRICAL SYSTEMS	CO1	Understand Conditionals, Iterables, Regex, Files, Error Handling, Data Structures, Algorithm design and Object-Oriented Python			3					
		CO2	Apply object-oriented programming, Python Standard Library, SciPy's optimization and Signal Processing and Linear algebra			3			2		
		CO3	Understand Data Analysis using Pandas. Apply supervised Learning and Unsupervised Learning techniques using Scikit-Learn	2		3					
		CO4	Analyse real world electrical engineering problems using panda power and PyPSA for power system modeling, analysis and optimization.			3					
		CO5	Analyze the applications of Python programming for electrical engineering applications			3					
22EE51A3 :	ENERGY MANAGEM	CO1	Understand data acquisition components of power system		3						

	ENT SYSTEMS	CO2	Understand energy data monitoring, reporting and communication		3						
		CO3	Apply supervisory control for energy management					3			
		CO4	Understand Energy management center functions	3							
22EE51B1:	OPTIMIZATION TECHNIQUES	CO1	Understand classical optimization techniques, describe clearly the problems with and without constraints, identify its parts and analyze the individual functions, Feasibility study for solving an optimization problem.				3				
		CO2	Apply mathematical translation of the verbal formulation of an optimization problem and design algorithms of linear programming problems, the repetitive use of which will lead reliably to finding an approximate solution.				3				
		CO3	Analyze and measure the performance of an algorithm of different methods to solve non-linear programming problems, study and solve optimization problems.				3				
		CO4	Analyze optimization techniques using algorithms. Investigate study, develop, organize and promote innovative solutions for various applications.				3				
22EE51B2	ADVANCED CONTROL THEORY	CO1	Apply the mathematical representation to dynamic systems		3						
		CO2	Apply the techniques to design the controllers	3							
		CO3	Apply the techniques to identify non linear system stability					3			
		CO4	Apply the algorithms for stability analysis		3						
22EE51B3	MODEL BASED DESIGN FOR ELECTRICAL SYSTEMS	CO1	Apply principle of system model derivation and finite element analysis		3						
		CO2	Model DC machines using computer aided design principles	2							
		CO3	Model advanced motors using computer aided design principles					2			
		CO4	Model electric vehicles using computer aided design principles		3						
22EE52A1	DIGITAL SIMULATION OF POWER ELECTRONIC SYSTEMS	CO1	Design of non-isolated and isolated DC-DC converters	3	2						
		CO2	Understand the working of Resonant converters	3	2						
		CO3	Modelling of non-isolated DC -DC converters	3	2						
		CO4	Design of closed loop controls for switched mode power supplies	3	2						
22EE52A2	SWITCHED MODE POWER SUPPLIES	CO1	Understand Pspice modelling of power semiconductor devices and passive components behaviour with protection circuits.	3						2	3

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		CO2	Analyse performance of AC-DC controlled, uncontrolled converters and DC-DC converters using Pspice and MATLAB Simulink model.		3					2	
		CO3	Evaluate DC-AC converters performance using modern simulation tools.	3						2	3
		CO4	Analyse AC voltage controller and cyclo-converter performance with programming and simulation tools.		2					2	
22EE52A3	ADAPTIVE CONTROL SYSTEMS	CO1	Outline elements of propbability and Stochastic processes		3						2
		CO2	Demonstrate parametric and non-parmetric system models		3						2
		CO3	Interpret adaptive control techniques to linear systems		3						2
		CO4	Apply adaptive control process and asses stability of linear systems		3			3			2
22EE52B1	GREEN ENERGY FOR ELECTRIC VEHICLE TECHNOLOGY	CO1	Understand the basic concepts of thermos dynamics	3		3					
		CO2	Understand Renewable Energy Sources	3		3					
		CO3	Understand Energy Storage Technology	3		3					
		CO4	Understand Charging Technology and Future scope of EV	3		3					
22EE52B2	AUTONOMOUS VEHICULAR TECHNOLOGY	CO1	Understand the the concepts of Autonomous Vehice Technology	3		3					
		CO2	Understand the concept of remote sensing and the types of sensor technology needed to implement remote sensing	3		3					
		CO3	Understand the concept of wireless standards and the fundamentals of on-board vehicle networks	3		3					
		CO4	Apply fundamentals of sensor data fusion as it relates to ADAS and Become familiar with modern vehicle display/cluster technology	3		3					
22E52B3	HYBRID & FUEL CELL VEHICLES	CO1	Understand the basics of conventional vehicle and history of HEV	3		2					
		CO2	Discriminate various motors used for HEV	3		2					
		CO3	Identify various energy storage systems for HEV	3					2		
		CO4	Understand the function of EMS in HEV		3	3					

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Y22 M.TECH ELECTRIC VEHICLE TECHNOLOGY							PO						PSO	
SL	Course Code	Course Title	L	T	P	Cr	1	2	3	4	5	6	1	2
1.	22EE5101	ELECTRIC VEHICLE POWER TRAIN DESIGN	3	1	0	4	3	3			3			
2.	22EE5102	BATTERY MODELLING AND STATE ESTIMATION	3	1	2	5	3		3		3	3		
3.	22EE5103	MECHANICAL DESIGN OF VEHICLE	3	0	2	4	3	3						
4.	22EE5104	EMBEDDED CONTROLLERS AND APPLICATIONS	3	0	2	4			3		3			
5.	22EE5211	ADVANCED ELECTRICAL DRIVES	3	1	2	5	3	2						
6.	22EE5202	FAULT DIAGNOSIS & CONTROL OF ELECTRIC VEHICLE	3	1	0	4	3		2		3	3		2
7.	22EE5203	CHARGING STATION DESIGN	3	0	2	4	3	2	2			2		
8.	22EE5204	AI AND IOT FOR MODERN ELECTRICAL SYSTEMS	3	1	0	4		3	3			2		
9.	22EE51A1	RELIABILITY ENGINEERING	3	0	0	3	3							
10.	22EE51A2	APPLICATION OF PYTHON PROGRAMMING IN ELECTRICAL SYSTEMS	2	0	2	3	2	3				2		
11.	22EE51A3	ENERGY MANAGEMENT SYSTEMS	3	0	0	3	3	3			3			
12.	22EE51B1	OPTIMIZATION TECHNIQUES	3	0	0	3				3				
13.	22EE51B2	ADVANCED CONTROL THEORY	3	0	0	3	3	3			3			
14.	22EE51B3	MODEL BASED DESIGN FOR ELECTRICAL SYSTEMS	3	0	0	3	2	3		2				
15.	22EE52A1	DIGITAL SIMULATION OF POWER ELECTRONIC SYSTEMS	3	0	0	3	3	2						
16.	22EE52A2	SWITCHED MODE POWER SUPPLIES	3	0	0	3	3	3					2	
17.	22EE52A3	ADAPTIVE CONTROL SYSTEMS	3	0	0	3		3			3			2
18.	22EE52B3	HYBRID & FUEL CELL VEHICLES	3	0	0	3	3	3	3			2		
19.	22EE52B1	GREEN ENERGY FOR ELECTRIC VEHICLE TECHNOLOGY	3	0	0	3	3		3					
20.	22EE52B2	AUTONOMOUS VEHICULAR TECHNOLOGY	3	0	0	3	3		3					
21.	22IE5149	Seminar	0	0	4	2	3	3	3	3	3		3	3
22.	21IE5250	Term Paper	0	0	4	2	3	3	3	3	3		3	3
23.	21IE6150	Dissertation	0	0	36	18	3	3		3	2	2	3	3
24.	21IE6250	Dissertation	0	0	36	18	3	3	3	3	3	2	3	3

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22EE5101: ELECTRIC VEHICLE POWER TRAIN DESIGN

L-T-P-S: 3-1-0-0 **Credits: 4** **Pre-Requisite: NIL**

Mapping of Course Outcomes with PO/PSO:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the History, Economics, Environmental issues and power train of Electric Vehicles	5	1
CO2	Analyze the dynamics of EV	2	4
CO3	Select and size the power train for 2W	1	3
CO4	Select and size the power train for 4W	1	3

Syllabus:

HISTORY, ECONOMIC & ENVIRONMENTAL IMPACT OF ELECTRIC VEHICLE

History of EV, Case studies on Economic and Environment aspects of EV, EV markets – Supply and demand, Economical analysis with case study, Environmental impact analysis with case study. Impact of different transportation technologies on environment and energy supply.

Power train components: BEV, HEV, PHEV and FCEV including working of Fuel cell, **Super capacitor, energy management, Hybrid sources.**

INTRODUCTION TO EV DYNAMICS

Motion and dynamic equations of electric vehicles, General description of vehicle movement, Vehicle resistance, Dynamic equation, Tire Ground Adhesion and maximum tractive effort, different drive cycles for, Drive cycles for vehicle emission, fuel consumption and performance testing.

2W POWER TRAIN SIZING

Chassis, differential and transmission selection for different drive trains, Battery, converter and motor drive sizing for different 2W drive trains. Analysis on the effect of sizing of different components for different drive cycles

4W POWER TRAIN SIZING

Chassis, differential and transmission selection for different drive trains, Battery, converter and motor drive sizing for different 4W drive trains. Analysis on the effect of sizing of different components for different drive cycles

Text books:

1. "A History of Electric Vehicles" by Nigel Burton, Edition -1, Crowood Publisher.
2. "Electric Cars: The Ultimate Guide for Understanding the Electric Car And What You Need to Know" by Brad Durant

Reference books:

1. "Electric Vehicle Technology Explained" by James Larminie and John Lowry.

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22EE5102: Battery Modelling and State Estimation

L-T-P-S: 3-1-2-0 Credits: 5 Pre-Requisite: NIL

Mapping of Course Outcomes with PO/PSO:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand the specifications and Li-ion chemistry	1	2
CO2	Understand the key functions of Battery management systems	1	2
CO3	Develop Enhanced Self Correcting (ESC) Model of battery	6	4
CO4	Develop Algorithms for SOC estimation of battery	5	4
CO5	Analyse Modelling and state estimation through experimental techniques	3 .	4

Syllabus:

Battery specifications and L-ion chemistry

Battery specifications, cell-module-pack formation and specification calculation, working principle of Li-ion cell, materials used for various components of Li-ion cell, different li-ion chemistries and there specification comparison

Functions of battery-management systems

BMS architecture, BMS functionality: Sensing and High Voltage Control, Protection-isolation, overvoltage, overcurrent protection, Performance-Battery pack energy and power calculations using HPPC, Balancing- passive and active cell balancing, Interface, and Diagnostics

Battery Modelling

Simple OCV model, Rint model, Thevinins model, Hysteresis effect and ESC model of battery cell.Charge, discharge tests to determine battery cell parameters,

SOC estimation

Stoichiometry for SOC estimation, Look-table method and Coulomb counting methods and their limitation for accurate state estimation. Linear and nonlinear Kalman filter based estimation techniques

Text books:

1. Battery management systems: Battery Modeling ,Gregory L.Plett, Artech house, 2015.
2. Battery management systems: Equivalent circuit methods ,Gregory L.Plett, Artech house, 2015.

Reference books:

1. Hybrid Electric vehicles-Principles and Applications with practical perspectives, Chris Mi, M. AbdulMasrur and David Wenzhong Gao, Wiley Publications,1edition 2011
2. Electric and Hybrid Vehicles power sources, models, sustainability, infrastructure and the market, Edited by Gianfranco Pistoia, Elsevier 1 edition 2010.
3. Electric and Hybrid Vehicles Design Fundamentals, by Iqbal Hussain, CRC Press2nd edition, 2010.

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22EE5103: Mechanical design of Vehicle

L-T-P-S: 3-0-2-0 Credits: 4 Pre-Requisite: NIL

Mapping of Course Outcomes with PO/PSO:

CO#	Course Outcome	PO/PSO	BTL
CO1	Identify different car body and body materials.	1	3
CO2	Identify design features of frame, front axle, and steering system	2	3
CO3	Model Suspension and Wheel system for vehicle	1	3
CO4	Model the braking system for vehicle	2	3

Syllabus:

CAR BODY, BODY MATERIALS AND TRIM MECHANISMS: Classification of Car Body: Saloon-Convertibles-Limousine-Estate Car-Racing and Sports Car- Car Body Construction- Electric Car Body Construction-Steel Sheet-Timber-Plastic-GRP- Properties of Materials-Corrosion-Anticorrosion Methods-Selection of Paint and Painting Process-Body Trim Items- Body Mechanisms. **LAYOUT, FRAME, FRONT AXLE AND STEERING SYSTEM:** Basic Construction of Chassis, Types of Chassis Layout with Reference to Power Plant Location and Drive-Various Types of Frames-Loads Acting on Vehicle Frame-Materials for Frames- Types of Front Axles and Stub Axles-Front Wheel Geometry-Castor-Camber-King Pin Inclination and Toe In-Toe Out-Condition for True Rolling Motion-Ackerman's and Davis Steering Mechanisms- Reversible and Irreversible Steering-Over Steer and Under Steer-Different Types of Steering Gear Boxes- Power Assisted Steering. **SUSPENSION SYSTEM, WHEELS AND TYRES**: Requirements of Suspension System-Types of Suspension-Constructional Details and Characteristics of Single Leaf-Multi–Leaf Spring-Coil Spring and Torsion Bar-Rubber-Pneumatic and Hydro Elastic Suspension-Independent Suspension System-Shock Absorbers-Types of Wheels-Wheel Rims-Construction of Tyres and Tyre Specifications. **BRAKING SYSTEM**: Need for Brake System-Stopping Distance-Leading and Trailing Shoes-Braking Torque-Types and Constructional Details-Drum Brakes and Disc Brakes-Hydraulic Braking System- Mechanical Braking System-Pneumatic Braking System-Power Assisted Braking System-Anti Lock Braking System.

Text books:

1. Donald E. Malen, 'Fundamentals of Automobile Body Structur Design'SAE International, 2011.
2. Geoff Davies, 'Materials for Automobile Bodies', Butterworth-Heinemann, 2012.

Reference books:

1. 1. Powloski J, 'Vehicle Body Engineering', Business Books Ltd., 1998.
2. James E Duffy, 'Body Repair Technology for 4-Wheelers',Cengage Learning, 2009.
3. Crouse and Anglin, 'Automotive Mechanism', 9th Edition. Tata McGraw-Hill, 2003.
4. Jack Erjavec, 'A Systems Approach to Automotive Technology', Cengage Learning Pub.,2009
5. T. K. Garrett, K. Newton and W. Steeds, 'Motor Vehicle', Butterworth, Heinemann, 13th Edition, 2000.

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22EE5104: Embedded Controllers and Applications

L-T-P-S: 3-0-2-0 **Credits: 4** **Pre-Requisite: NIL**

Mapping of Course Outcomes with PO/PSO:

CO#	Course Outcome	PO/PSO	BTL
CO1	Apply Programming of 8051 Microcontroller for general purpose applications	3	3
CO2	Apply programming concepts of 8051 for interfacing peripherals	3	3
CO3	Demonstrate Architecture and Programming of PIC Microcontoller	3	3
CO4	Apply programming concepts of 8051 and PIC Microcontroller for interfacing peripherals	3	3
CO5	Build Assembly languiage and C language programming Applications of 8051 and PIC microcontroller	3,5	3

SYLLABUS:

8051 Microcontroller functional aspects: Microcontroller families, 8051 Architecture- Signal Description, Register organization, Internal RAM, Special Function Registers, Addressing modes, Instruction set, Interrupts, Timer/Counter module, Serial Data Communication module, and RS-232C Standard.

8051 Programming & Interfacing: Simple Programs involving Arithmetic and Logical Instructions, Timers/Counters, Serial Communication & Interrupts. Matrix Key Board interface, Stepper Motor interface, LCD interface

PIC Microcontroller functional aspects: Introduction, Architectural overview, Memory organization, interrupts and reset, I/O ports, Timers, C Programming PIC microcontroller

PIC microcontrollers Interface Applications: DAC Interfacing, ADC Interfacing, Digital relaying, Closed loop control of dc motor, speed encoder interface using CCP module

TEXT BOOKS:

1. 1.Mazidi&McKinley "The 8051 Micro controller and Embedded systems: using assembly and C, 2nd edition,2007.
2. Mazidi&McKinley, "PIC Microcontroller and Embedded Systems: Using assembly and C for PIC 18", 1st edition, 2008

REFERENCE BOOKS:

1. Rajkamal, "Microcontrollers - Architecture, Programming, Interfacing & System Design", 2nd edition, Pearson Education,2009.
2. Ted Van Sickle, "Programming Microcontrollers in C", 2nd edition, 2001.

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22EE5211: ADVANCED ELECTRICAL DRIVES

L-T-P-S: 3-1-2-0 Credits: 5 Pre-Requisite: NIL

Mapping of Course Outcomes with PO/PSO:

CO#	Course Outcome	PO/PSO	BTL
1.	Understand the modeling of AC machines	PO1,PO2	2
2.	Contrast the speed control performance of 3-Phase induction and synchronous motor drive using vector control methods	PO1,PO2	4
3.	Analyze the dynamic behavior of SRM motor drives under various control methods	PO1,PO2	4
4.	Distinguish the performance of BLDC Motor drive using various control techniques	PO1,PO2	4
5	Analyze the applications of Python programming for electrical engineering applications	PO2	4

Syllabus:

FIELD ORIENTED CONTROL OF INDUCTION MOTOR DRIVES - Field oriented control of induction machines – Theory – DC drive analogy – Direct and Indirect methods – Flux vector estimation - Direct torque control of Induction Machines – Torque expression with stator and rotor fluxes, DTC control strategy. **SENSORLESS VECTOR CONTROL OF INDUCTION MOTOR**: Slip and Speed Estimation at Low performance, Rotor Angle and Flux-linkage Estimation at high performance -rotor Speed Estimation Scheme- estimators using rotor slot harmonics, Model Reference adaptive systems, Extended Kalman Filter. **CONTROL OF SYNCHRONOUS MOTOR DRIVES**: Self control-margin angle control-torque control-power factor control-Brushless excitation systems - SRM Structure-Stator Excitation-techniques of sensor less operation-convertor topologies-SRM Waveforms-SRM drive design factors-Torque controlled SRM-Torque Ripple-Instantaneous Torque control -using current controllers-flux controllers. **CONTROL OF BLDC MOTOR DRIVES**: principle of operation of BLDC Machine, Sensing and logic switching scheme, BLDM as Variable Speed Synchronous motor-methods of reducing Torque pulsations -Three-phase full wave Brushless dc motor -Sinusoidal type of Brushless dc motor - current controlled Brushless dc motor Servo drive.

TEXT BOOKS

1. Electric Motor Drives Modeling, Analysis & control -R. Krishnan- Pearson Education
2. Modern Power Electronics and AC Drives –B. K. Bose-Pearson Publications
3. Sensorless Vector Direct Torque control –Peter Vas, Oxford University Press

REFERENCES BOOKS

1. Modern Power Electronics and AC Drives –B. K. Bose-Pearson Publications-
2. Power Electronics control of AC motors – MD Murphy & FG Turn Bull Pergman Press -1st edition-1998
3. W.Leonhard, "Control of Electrical Drives", Narosa Publishing House, 1992
4. VedamSubramanyam, "Electric Drives – Concepts and Applications", Tata McGraw-Hill publishing company Ltd., New Delhi, 2002

22EE5202: FAULT DIAGNOSIS & CONTROL OF ELECTRIC VEHICLE

L-T-P-S: 3-1-0-0 **Credits: 4** **Pre-Requisite: NIL**

Mapping of Course Outcomes with PO/PSO:

CO#	Course Outcome	PO/PSO	BTL
CO1	Apply characteristics of sensors and actuators used for electric vehicle control	1,3	2
CO2	Apply usage of microcontroller for digital control of electric vehicle	1,5	2
CO3	Apply communication protocols for data communication in electric vehicle control system	5	3
CO4	Model fault diagnosis system for electric vehicle	5	3

Syllabus:

Sensors and actuators: Sensors: Accelerometers, Wheel speed, Brake pressure, Seat occupancy, Motor speed, Steering wheel angle, Vehicle speed, Throttle position, Turbine speed, Temperature, Mass air flow (MAF) rate, Throttle plate angular position, and Air bag sensors, Actuators: Relays, Solenoids, motors and piezoelectric force generators, Chassis control systems , Automatic transmission control systems Micro-controller functions PIC controller basics: Ports, Timer/Counters, Interrupts, Watchdog timers and PWM Development of control algorithms for different automotive subsystems: Look-up tables and maps, Need of maps, Procedure to generate maps, Fuel maps/tables, Ignition maps/tables, Motor calibration, Torque table, Dynamometer testing. Communication protocols and Infotainment systems Overview of automotive communication protocols, CAN, LIN , Flex Ray, MOST , Ethernet, D2B and DSI, Communication interface with ECUs, Interfacing techniques and Interfacing with infotainment gadgets, Relevance of Protocols such as TCP/IP for automotive applications, Wireless LAN standards such as Bluetooth, IEEE 802.11x communication protocols for automotive applications. Infotainment Systems: Application of telematics in automotive domain, Global positioning systems (GPS) and General packet radio service (GPRS).Fault Diagnosis Fundamentals of Diagnostics, Basic wiring system and Multiplex wiring system, Preliminary checks and adjustments, Self-diagnostic system, Fault finding and corrective measures, Electronic transmission checks and Diagnosis, Diagnostic procedures and sequences, On-board and off-board diagnostics in Automobiles, OBDII, Concept of DTCs, DLC, MIL, Freeze Frames, History Memory, Diagnostic tools, Diagnostic protocols KWP2000 and UDS.

Text Books:

1. Williams. B. Ribbens: "Understanding Automotive Electronics", 6th Edition, Elsevier Science, Newnes Publication, 2003.
2. Robert Bosch: "Automotive Electronics Handbook", John Wiley and Sons, 2004

Reference Books:

1. Ronald K Jurgen: "Automotive Electronics Handbook", 2nd Edition, McGraw-Hill, 1999.
2. James D. Halderman: "Automotive Electricity and Electronics", PHI Publication..
3. Allan Bonnick: "Automotive Computer Controlled Systems, Diagnostic Tools and Techniques", Elsevier Science, 2001
4. G. Meyer, J. Valldorf and W. Gessner: "Advanced Microsystems for Automotive Applications", Springer, 2009

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22EE5203: CHARGING STATION DESIGN

L-T-P-S: 3-0-2-0 Credits: 4 Pre-Requisite: 22EE5101

Mapping of Course Outcomes with PO/PSO:

CO#	Course Outcome	PO/PSO	BTL
CO1	Interpret Power electronic converters for electric vehicle charging	1,2	2
CO2	Develop control algorithms for various electric vehicle charging modes	1,3	3
CO3	Demonstrate charging station infrastructure	1,6	3
CO4	Demonstrate installation of charging station	1	2

Syllabus:

Charger Topologies

Charging time and charging speed, Defining power levels- Normal charging, Semi-fast charging, Overview of power levels ,DC conductive charging, AC conductive charging, Low power Charger, Automotive standard charger, High power topologies, Multi-port Charger.

Power Electronics for EV Battery Charging

Forward/ Flyback Converters, Half-Bridge DC–DC Converter, Full-Bridge DC–DC Converter, Power Factor Correction, Bidirectional Battery Chargers, Dual active bridge dc-dc converter, Solar charging station.

Charging Modes

Constant-current charging, Constant-voltage charging, Pulse Charging, Reflex charging, Float charge, Trickle Charge, Load management at charging station and peak load management

Charging Infrastructure

Charger - Existing National & International Charger Architecture Standards - SAE J1773, VDE-AR-E 2623-2-2, JEVS G105-1993 (CHAdeMO), CCS, Type-1 AC, Type-2 AC, Bharat DC-001, Bharat AC-001.

Cords and Cables, Earthing, Fault Protection, Testing, Charging Safety, Protection against electric shock, Digital Communication between EV and Charging Station.

Installation

Govt. of India guideline on Public Charging Stations, IEC Standards- 60068-2(1, 2, 14, 30), 61683, 60227, 60502, 60947 part I,II, III and 61215.

Site assessment, EVSE Typical Site Plans, Design Guidelines and Site Drawings, Planning Considerations, Station Configuration, Selection and erection of electrical equipment - Isolation, switching and control.

Text books:

1. Power Electronics by Daniel W.Hart.
2. Power Electronics for Renewable Energy Systems, Transportation and industrial Applications by Haitham Abu-Rub, Mariusz Malinwoski, Kamal Al-Haddad.

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22EE5204: AI and IoT for Modern Electrical Systems

L-T-P-S: 3-1-0-0 **Credits: 4** **Pre-Requisite: NIL**

Mapping of Course Outcomes with PO/PSO:

CO#	Course Outcome	PO/PSO	BTL
CO1	Demonstrate IoT devices and tools	PO4	2
CO2	Operate the cloud system Environment	PO4	3
CO3	Utilize AI and ML Techniques	PO2	3
CO4	Utilize AI techniques for electrical systems	PO6	3

Syllabus:

IoT Devices and Enabling Technologies: IoT Architecture, IoT Infrastructures -Sensor Devices, Actuators, IoT protocols and software's- MQTT, UDP, MQTT-brokers, publish subscribe modes, HTTP, COAP, XMPP and gateway protocols, IoT point to point communication technologies, Selection of Wireless technologies - 6LoWPAN, Zigbee, WIFI, BT, BLE,SIG,NFC, LORA, Lifi and Widi.

Cloud Computing: Basics-Cloud systems, Cloud computing protocols, Role of Web services, Deployment Models- Public, Community, Hybrid, Private Clouds, Cloud Analytics over Thingspeak, Google Firebase, AWS-console, Functions. Database Services-Relational DBMS, RDS Services.

AI and ML on Cloud: Data Pre-processing techniques in Machine Learning, Data-handling, importing libraries, Data pre-processing using python, Missing data, Categorical Data. Regression and Classification algorithms in ML. Cloud based Real- time Monitoring systems, M2M communications, Case Studies **AI for Electrical Systems:** AI and Machine learning algorithms for Renewable technologies-PV MPP techniques, RMSE and MAPE analysis for short term irradiance, solar energy and load forecasting, temperature forecasting. Wind speed forecasting, Intelligent Energy Management System of Hybrid Solar/Wind/Battery Power Sources, Electric vehicle-BMS, case studies- smart cities, smart grid, smart building, electrical vehicles

Text Books:

1. AI and IoT in Renewable Energy, **Shaw**, R.N., **Mendis**, N., **Mekhilef**, S., **Ghosh**, A,Springer, 2011
2. Sensors and Actuators – D. Patranabis – 2nd Ed., PHI, 2013
3. Applications of AI and IoT in Renewable Energy, R.N., **Mendis**, N., **Mekhilef**, S., **Ghosh**, A, Elsevier, 2021

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22EE51A1: RELIABILITY ENGINEERING

L-T-P-S: 3-0-0-0 Credits: 3 Pre-Requisite: NIL

Mapping of Course Outcomes with PO/PSO:

CO#	Course Outcome	PO/PSO	BTL
CO 1	Understand the system reliability concepts	PO-1	2
CO 2	Apply the frequency and duration techniques for component repairable system.	PO-1	3
CO 3	Apply the network reliability concepts to generation system reliability analysis.	PO-1	3
CO 4	Apply the network reliability concepts to transmission and distribution system reliability analysis.	PO-1	3

Network Modelling and Reliability Analysis: Reliability concepts – exponential distributions – meantime to failure – series and parallel system – MARKOV process – recursive technique - Bath tub curve - reliability measures MTTF, MTTR, MTBF.**Frequency & Duration Techniques:**Frequency and duration concept – Evaluation of frequency of encountering state, mean cycle time, for one , two component repairable models – evaluation of cumulative probability and cumulative frequency of encountering of merged states. **Generation System Reliability Analysis:** Reliability model of a generation system– recursive relation for unit addition and removal – load modeling - Merging of generation load model – evaluation of transition rates for merged state model – cumulative Probability, cumulative frequency of failure evaluation – LOLP, LOLE. **Transmission System Reliability Analysis:** System and load point reliability indices – Weather effects on transmission lines – Weighted average rate and Markov model.: **Distribution System Reliability Analysis:** Basic Techniques – Radial networks – Evaluation of Basic reliability indices, performance indices - Load point and system reliability indices – Customer oriented, loss and energy oriented indices – Examples. Parallel Configuration: Basic techniques – Inclusion of bus bar failures, scheduled maintenance – Temporary and transient failures – Weather effects –Evaluation of various indices – Examples.

Text Books:

1. R. Billinton, R.N.Allan, "Reliability Evaluation of Power systems" second edition, Springer.
2. Charles E. Ebeling, "An Introduction to Reliability and Maintainability Engineering", TATA Mc Graw- Hill – Edition.

Reference Books:

1. R. Billinton, R.N.Allan, "Reliability Evaluation of Engineering System", Plenum Press, New York.
2. Eodrenyi, J., "Reliability modelling in Electric Power System", John Wiley, 1980

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22EE51A2: Application of Python Programming in Electrical Systems

L-T-P-S: 2-0-2-0 **Credits: 3** **Pre-Requisite: NIL**

Mapping of Course Outcomes with PO/PSO:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand Conditionals, Iterables, Regex, Files, Error Handling, Data Structures, Algorithm design and Object-Oriented Python	3	2
CO2	Apply object-oriented programming, Python Standard Library, SciPy's optimization and Signal Processing and Linear algebra	3,6	3
CO3	Understand Data Analysis using Pandas. Apply supervised Learning and Unsupervised Learning techniques using Scikit-Learn	1,3	3
CO4	Analyse real world electrical engineering problems using pandapower and PyPSA for power system modeling, analysis and optimization.	3	4
CO5	Analyze the applications of Python programming for electrical engineering applications	3	4

SYLLABUS:

Algorithm Design and Recursion, Searching, Recursive Problem Solving, Conditionals, Iterables & Regex in Python, Python Objects I: Strings, Python Objects II: Lists, Tuples and Loops, File Input/Output, Errors and Exceptions, Python Objects III: Dictionaries and Sets, An Introduction to Object-Oriented Programming, Stacks, queues, Linked Lists. Bubble, Quick, and Merge Sort.
Object oriented programming and classes, constructor, Inheritance – Implementing a subclass, Classes and polymorphism, Recursive calls to methods, Class variables, class methods, Class for Vectors in the Plane, Class for Complex Numbers, Classes for Numerical Differentiation, Classes for Numerical Integration, Python Standard Library, SciPy's optimization and Signal Processing. Linear Algebra: solve systems of linear equations, eigenvalues, and eigenvectors. Case study: analysis of vibrating strings or atoms Scikit-learn, Manipulating Tabular Data Using Pandas, Supervised Learning: Classification and Regression. Unsupervised Learning: Clustering, **Predictive Modelling / Machine Learning**: predictive algorithms, regression analysis, and clustering analysis from large databases.

Circuit analysis for series and parallel RLC circuits using PySpice, Power System stability and Analysis.Generating Graphical User Interface (GUI). Data Acquisition and Instrumentation Control: using a Raspberry Pi / Arduino and python code

Textbooks:

1. Object-Oriented Programming in Python —https://pythontextbok.readthedocs.io/en/1.0/
2. Christian Hill - Learning Scientific Programming with Python-Cambridge University Press (2020)
3. Robert Johansson, Numerical Python: Scientific Computing and Data Science Applications with Numpy, SciPy and Matplotlib, Apress (2019)

22EE51A3: ENERGY MANAGEMENT SYSTEMS

L-T-P-S: 3-0-0-0 **Credits: 3** **Pre-Requisite: NIL**

Mapping of Course Outcomes with PO/PSO:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand data acquisition components of power system	PO-2	2
CO2	Understand energy data monitoring, reporting and communication	PO-2	2
CO3	Apply supervisory control for energy management	PO-5	3
CO4	Understand Energy management center functions	PO-1	2

General Theory: Purpose and necessity, general structure, data acquisition, transmission and monitoring, general powersystem hierarchical structure, overview of the methods of data acquisition systems, commonly acquired data, transducers, RTUs, data concentrators, various communication channels, cables, telephone lines, power line carrier, microwaves, fiber- optical channels and satellites.**Supervisory and Control Functions:** Data acquisitions, status indications, measured values, energy values, monitoring alarm and event application processing. Control function: ON/OFF control of lines, transformers, capacitors and applications in process industry, valve, opening, closing etc. Regulatory functions: set points and feed-back loops, time tagged data, disturbance data collection and analysis, calculation and report preparation. **MAN- Machine Communication:** Operator consoles and VDUs, displays, operator dialogues, alarm and event loggers, mimic diagrams, report and printing facilities. **Data bases - SCADA, EMS and network data bases:** SCADA system structure - local system, communication system and central system, Configuration- non-redundant single processor, redundant dual processor, multi control centers, system configuration. Performance considerations: real time operation system requirements, modularization of software programming languages.**Energy Management Center** Functions performed at a centralized management center, production control and load management, economic dispatch, distributed centers and power pool management.

Textbooks:

1. TorstenCegrell, Power System Control Technology, Prentice Hall International, 1986
2. Stuart A. Boyer, SCADA: Supervisory Control And Data Acquisition, The Instrumentation, Systems and Automation Society, 4th edition, 2009.
3. Krishna Kant, Computer-Based Industrial Control, PHI Learning,2nd edition, 2013.
4. Bela G. Liptak, Instrument Engineers Handbook, Volume 3: Process Software and Digital Networks, CRC Press, 4th edition, 2011.
5. Behrouz Forouzan, Data Communications and Networking, McGraw-Hill,5**th**edition, 2012.

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22EE51B1: OPTIMIZATION TECHNIQUES

L-T-P-S: 3-0-0-0 **Credits: 3** **Pre-Requisite: NIL**

Mapping of Course Outcomes with PO/PSO:

CO#	Course Outcome	PO/PSO	BTL
CO1	Understand classical optimization techniques, describe clearly the problems with and without constraints, identify its parts and analyze the individual functions, Feasibility study for solving an optimization problem.	4	2
CO2	Apply mathematical translation of the verbal formulation of an optimization problem and design algorithms of linear programming problems, the repetitive use of which will lead reliably to finding an approximate solution.	4	3
CO3	Analyze and measure the performance of an algorithm of different methods to solve non-linear programming problems, study and solve optimization problems.	4	4
CO4	Analyze optimization techniques using algorithms. Investigate study, develop, organize and promote innovative solutions for various applications.	4	4

Syllabus:

Classical Optimization Techniques: Single variable optimization, multi-variable optimization with no constraints, with equality and inequality constraints, Karush- Kuhn- Tucker constraints.

Linear Programming (LP): Geometry of LP problem, graphical solution, simplex algorithm, two-phases of simplex algorithm, duality, dual simplex method, quadratic programming.

Non-Linear Programming: One-dimensional optimization – Fibonacci method, golden section method, quadratic and cubic interpolation methods, Newton's method.Unconstrained optimization - Steepest descent method, conjugate gradient method, Davidon-Fletcher-Powell method. Constrained Optimization - Augmented Legrangian multiplier method, Branch and bound method

Non-traditional Optimization Methods and Applications: Genetic algorithms (G A), G A Operators, G A for constrained optimization. Particle swarm optimization (PSO).

Text Books:

1. S.S. Rao, 'Engineering Optimization : Theory andPractice.III Edition, New Age International (p) Limited Publications

2. Kalyanmoy Deb, 'Optimization for Engineering Design', PHI Learning Private Limited.

Reference Books:

1. PurnachandraBiswal, ' Optimization in Engineering', Scitech Publications (India) PVT Ltd.

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22EE51B2: Advanced Control Theory

L-T-P-S: 3-0-0-0 Credits: 3 Pre-Requisite: NIL

Mapping of Course Outcomes with PO/PSO:

CO#	Course Outcome	PO/PSO	BTL
1	Apply the mathematical representation to dynamic systems	PO2	3
2	Apply the techniques to design the controllers	PO1	3
3	Apply the techniques to identify non linear system stability	PO-5	3
4	Apply the algorithms for stability analysis	PO-2	3

Mathematical Preliminaries and State Variable Analysis:Fields, Vectors and Vector Spaces – Linear combinations and Bases – Linear Transformations and Matrices – Scalar Product and Norms – Eigen values, Eigen Vectors and a Canonical form representation of Linear systems – The concept of state – State space model of Dynamic systems – Time invariance and Linearity – Non uniqueness of state model – State diagrams for Continuous-Time State models – Existence and Uniqueness of Solutions to Continuous-Time State Equations – Solutions of Linear Time Invariant Continuous-Time State Equations – State transition matrix and it's properties. Complete solution of state space model due to zero input and due to zero state.

Controllability and Observability: General concept of controllability – Controllability tests, different state transformations such as diagonalization, Jordon canonical forms and Controllability canonical forms for Continuous-Time Invariant Systems – General concept of Observability – Observability tests for Continuous-Time Invariant Systems – Observability of different State transformation forms. State Feedback Controllers and Observers: State feedback controller design through Pole Assignment, using Ackkermans formula– State observers: Full order and Reduced order observers.

Non-Linear Systems: Introduction – Non Linear Systems – Types of Non-Linearities – Saturation – Dead-Zone – Backlash – Jump Phenomenon etc; Linearization of nonlinear systems, Singular Points and its types– Describing function–describing function of different types of nonlinear elements, – Stability analysis of Non-Linear systems through describing functions. Introduction to phase-plane analysis, Method of Isoclines for Constructing Trajectories, Stability analysis of nonlinear systems based on phase-plane method.

Stability Analysis: Stability in the sense of Lyapunov, Lyapunov's stability, and Lypanov's instability theorems – Stability Analysis of the Linear continuous time invariant systems by Lyapunov second method – Generation of Lyapunov functions – Variable gradient method – Krasooviski's method.

TEXT BOOKS:

1. M. Gopal, Modern Control System Theory by – New Age International – 1984
2. Ogata. K, Modern Control Engineering by– Prentice Hall – 1997
3. N K Sinha, Control Systems– New Age International – 3rd edition.

REFERENCE BOOKS:

1. Donald E. Kirk, Optimal Control Theory an Introduction, Prentice – Hall Network series – First edition.

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22EE51B3: Model based Design for Electrical Systems

L-T-P-S: 3-0-0-0 Credits: 3 Pre-Requisite: NIL

Mapping of Course Outcomes with PO/PSO:

CO#	Course Outcome	PO/PSO	BTL
1	Apply principle of system model derivation and finite element analysis	PO2	3
2	Model DC machines using computer aided design principles	PO1	3
3	Model advanced motors using computer aided design principles	PO-5	3
4	Model electric vehicles using computer aided design principles	PO-2	3

Syllabus:

BASIC CONCEPTS OF DESIGN: Introduction; Specification; Output coefficient; Importance of specific loadings; Electrical Materials: Conducting Materials, Insulating Materials and Magnetic Materials; Magnetic circuit calculations; General procedure for calculation of Amp-Turns; Heating and Cooling; Modes of heat dissipation; Standard ratings of Electrical machines; Ventilation in rotating machines; Quantity of cooling medium; Types of enclosures; General design procedure; Steps to get optimal design. Application of finite element method in design. **SIMULATION AIDED DESIGN OF DC MACHINES** Introduction; Flowcharts and programs for computer aided design of DC machines. 2D FEM open-source software-based DC machine part design **SIMULATION AIDED DESIGN OF INDUCTION MOTOR &SPECIAL MACHINES** Introduction; Flowcharts and programs for simulation aided design of Induction motor, 2D FEM open-source software-based Induction motor part design, computer aided design of BLDC, SRM and PMSM motors **MODEL BASED SYSTEM DESIGN FOR ELECTRIC VEHICLE CONVERSION** Introduction, EV conversion prototyping development, EV conversion ECU design and in-the-loop testing, EV conversion tuning and diagnostic method – Generation of Lyapunov functions – Variable gradient method – Krasooviski's method.

TEXT BOOKS:

1. M. Gopal, Modern Control System Theory by – New Age International – 1984
2. R. Krishnan, 'Electric Motor & Drives: Modeling, Analysis and Control', Prentice Hall of India, 2nd Edition, 2001.

REFERENCE BOOKS:

1. Donald E. Kirk, Optimal Control Theory an Introduction, Prentice – Hall Network series – First edition.
2. N K Sinha, Control Systems– New Age International – 3rd edition.

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22EE52A1: Digital Simulation of Power Electronic Converters

L-T-P-S: 3-0-0-0 Credits: 3 Pre-Requisite: NIL

Mapping of Course Outcomes with PO/PSO:

CO#	Course Outcome	PO/PSO	BTL
CO1	Design of non-isolated and isolated DC-DC converters	PO1,PO2	4
CO2	Understand the working of Resonant converters	PO1,PO2	2
CO3	Modelling of non-isolated DC -DC converters	PO1,PO2	3
CO4	Design of closed loop controls for switched mode power supplies	PO1,PO2	4

SYLLABUS :

Non isolated dc-dc converters: Introduction to dc-dc power supplies-Analysis and design of Buck, Boost, Cuk and SEPIC converters in continuous and discontinuous conduction modes-verification of theoretical analysis of converters using simulation tools

Isolated dc-dc converters: Introduction to dc-dc power supplies with isolation- Analysis and design of Forward and fly-back, Push-Pull, Half bridge and full-bridge converters in continuous and discontinuous conduction modes-verification of theoretical analysis of converters using simulation tools

Resonant converters: Introduction to soft switching techniques, analysis and design of load resonant converters-Series load resonant converter-parallel load resonant converter and hybrid resonant converter - Resonant switch converter- Zero current switching, Zero voltage switching and Zero voltage switching with clamped voltage, comparison of Resonant converter topologies.

Modeling of Non isolated dc-dc converters:

Introduction to small signal Analysis- small signal Analysis of Buck, Boost , Buck-Boost converters in continuous and discontinuous conduction modes using averaged switch models, stability analysis of converters using transfer functions (open loop) derived from small signal Analysis

Closed loop control of converters: Introduction to control of switch mode dc power supplies, voltage feedback, voltage feed forward, current mode PWM control of DC-DC converters, power supply protection and electrical isolation in feedback loop

Text books:

1. Power Electronics Converters, applications & devices- Mohan, Undeland Robbins, Wiley Publications, 2003
2. Power Electronics by Daniel W.Hart , Tata McGraw-Hill publication.2011

Reference Books:

1. Power – Switching Converters; Second Edition by Simon Ang & Alejandro Oliva, CRC Publications,2005
2. Fundamentals of Power Electronics-R.W.Erickson and D.Maksimovic-second edition –kluwer publishers,sixth printing-2004.
3. Power Electronics and applications by L. Umananand Wiley India publications.2009

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22EE52A2: Switched Mode Power Supply and PWM Techniques

L-T-P-S: 3-0-0-0 Credits: 3 Pre-Requisite: NIL

Mapping of Course Outcomes with PO/PSO:

=CO No	Course Outcome (CO)	PO	Blooms Taxonomy Level (BTL)
CO1	Understand Pspice modelling of power semiconductor devices and passive components behaviour with protection circuits.	PO1,PO2/ PSO1	2
CO2	Analyse performance of AC-DC controlled, uncontrolled converters and DC-DC converters using Pspice and MATLAB Simulink model.	PO1,PO2/ PSO1	4
CO3	Evaluate DC-AC converters performance using modern simulation tools.	PO1,PO2/ PSO1	4
CO4	Analyse AC voltage controller and cyclo-converter performance with programming and simulation tools.	PO1,PO2/ PSO1	4

SYLLABUS:

MODELLING OF POWER ELECTRONIC DEVICES: General purpose circuit analysis software – Methods of analysis of power electronic systems - Transients and the time domain analysis with Pspice – Fourier series and harmonic components – Pspice modelling of diode, BJT,MOSFET,IGBT, SCR,TRIAC in simulation. Diode with R, R-L, R-C and R-L-C load with ac supply. Modelling of SCR, TRIAC and IGBT, simulation of driver and snubber circuits. **SIMULATION OF AC-DC CONVETERS USING PSPICE AND MATLAB SIMULINK**: Modelling of single phase and three-phase uncontrolled and controlled (SCR) rectifiers- simulation of converter fed DC drives-computation of performance parameters: harmonics, power factor, angle of overlap. **SIMULATION OF DC-DC CONVERTERS USING PSPICE AND MATLAB SIMULINK:**Modelling of Chopper circuits- Simulation of thyristor choppers with voltage, current and load commutation schemes- Simulation of chopper fed dc motor- computation of performance parameters. **SIMULATION OF DC-AC CONVERTERS USING PSPICE AND MATLAB SIMULINK:**Modelling of single and three phase inverters circuits – Space vector representation- Pulse-width modulation methods for voltage control- Simulation of inverter fed induction motor drives. **SIMULATION OF AC-AC CONVERTERS USING PSPICE AND MATLAB SIMULINK:**Modelling of AC voltage controllers, and Cyclo-converters- Simulation of AC voltage controllers and Cyclo-converters feeding different loads- Computation of performance parameters.

TEXT BOOKS:

1. Rashid, M., "Simulation of Power Electronic Circuits using PSPICE", Prentice Hall Inc., 2006
2. M. B. Patil, V. Ramnarayanan and V. T. Ranganathan., "Simulation of Power Electronic Converters", 1st Edition, Narosa Publishers, 2010.
3. John Keown., "Microsim, Pspice and circuit analysis"-Prentice Hall Inc., third edition, 1998.

REFERENCE BOOKS:

1. Robert Ericson, 'Fundamentals of Power Electronics', Chapman & Hall, 1997.
2. IssaBatarseh, 'Power Electronic Circuits', John Wiley, 2004Simulink Reference Manual, Math works, USA.
3. Rashid, M., "Power Electronic Circuits, Devices and Applications", Pearson Education Inc.,2004.

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22EE52A3: Adaptive Control Systems

L-T-P-S: 3-0-0-0 **Credits: 3** **Pre-Requisite: NIL**

Mapping of Course Outcomes with PO/PSO:

CO#	Course Outcome	PO/PSO	BTL
CO1	Outline elements of propbability and Stochastic processes	PO2/PSO1	2
CO2	Demonstrate parametric and non-parmetric system models	PO2/PSO1	2
CO3	Interpret adaptive control techniques to linear systems	PO2/PSO1	2
CO4	Apply adaptive control process and asses stability of linear systems	PO2,PO5/PSO2	3

Elements of probability theory: definition of probability and random variable, probability functions, expected value, mean and covariance, independence and correlation, Gaussian distribution and its properties. **Stochastic processes and system models:** Elements of the theory of stochastic processes, mean value function and covariance kernel, independent and correlated stochastic processes, stationery and non sequence model, Gaussian white process. **Non parametric methods & parametric methods:** Nonparametric methods: Transient analysis-frequency analysis-Correlation analysis-Spectral analysis. Liner Regression: The Lease square estimate-best liner unbiased estimation under linear constraints-Prediction error methods: Description of Prediction error methods-Optimal Prediction –relationships between Prediction error methods and other identification methods theoretical analysis. **Adaptive control schemes** Introduction – users- Definitions-auto tuning-types of adaptive control-gain scheduling controller-model reference adaptive control schemes – self tuning controller. MRAC and STC: Approaches – The Gradient approach – Lyapunov functions – Passivity theory – pole placement method Minimum variance control – Predictive control. **Adaptive control and application:** Stability – Convergence – Robustness – Application of adaptive control, direct model reference adaptive control. Introduction: Basic approaches to adaptive control. Applications of adaptive control. Identification: Error formulations linear in the parameters. Direct adaptive control: Linear error equations with dynamics. Gradient and pseudo-gradient algorithms. Strictly positive real transfer functions. Kalman-Yacubovitch-Popov lemma, Passivity theory.

TEXT BOOKS:

1. Dan Simon, "Optimal State Estimation", Wiley Intersience, 2006.
2. S. Sastry and M. Bodson, Adaptive Control: Stability, Convergence, and Robustness, Prentice-Hall, 1989.

REFERENCE BOOKS:

1. K.J. Astrom and B. Wittenmark, Adaptive Control, Addison-Wesley, 2nd edition, 1995.
2. I.D. Landau, R. Lozano, and M. M'Saad, Adaptive Control, Springer Verlag, London, 1998.
3. Meditch, "Stochastic Optimal Linear Estimation and Control" Mc-Graw Hill Company, 1969.
4. K.S. Narendra and A.M. Annaswamy, Stable Adaptive Systems, Prentice-Hall, 1989.
5. P.E. Wellstead& M.B. Zarrop, Self-Tuning Systems: Control and Signal Processing, J. Wiley & Sons, Chichester, England, 1991

22EE52B1: GREEN ENERGY VEHICLE TECHNOLOGY

L-T-P-S: 3-0-0-0 **Credits: 3** **Pre-Requisite: NIL**

Mapping of Course Outcomes with PO/PSO:

CO#	Course Outcome	PO/PSO	BTL
1	Understand the basic concepts of thermos dynamics	1,3	2
2	Understand Renewable Energy Sources	1,3	2
3	Understand Energy Storage Technology	1,6	2
4	Understand Charging Technology and Future scope of EV	2,3	3

Syllabus:

Introduction:- Review of thermodynamics; Energy Demand and Supply Outlook; Climate Change: projections and risks. Non-renewable Energy sources (Coal, Oil, Natural Gas, Nuclear) and their impact on the environment (climate change , atmospheric pollution, radioactive waste);

Renewable Energy Sources - Wind, Solar PV, Solar-Thermal, Geo-thermal, Hydropower – technology and deployment; Carbon Neutral Fuels – biomass to fuel conversion, biofuel combustion technology, hydrogen as fuel, CO2 to fuel conversion, fuel cell technology;

Energy Storage Technology – chemical storage and battery technology, electro-mechanical storage, thermal storage; Energy Efficiency and Emission Reduction – Use of Exergy to optimize energy use, Clean Combustion Technology, Carbon Capture and Storage, Energy efficient buildings, Life Cycle Assessment (LCA), Distributed Energy and Smart Grid systems.

Charging Technology and Future scope of EV: Sizing the drive system, Energy Management Strategies, Automotive networking and communication, EV charging standards, V2G, G2V, V2B, V2H. Business: E-mobility business, electrification challenges, Business- E-mobility business, electrification challenges, Connected Mobility and Autonomous Mobility- case study E-mobility Indian Roadmap Perspective

Text Books:

1. Autonomous Driving: How the Driverless Revolution will Change the World, by Andreas Herrmann, Walter Brenner, Rupert Stadler, ISBN-10 1787148343, ISBN-13 978-1787148345, Emerald Publishing Limited, 26 March 2018.
2. Autonomous Vehicles: Technologies, Regulations, and Societal Impacts, George Dimitrakopoulos, Aggelos Tsakanikas, Elias Panagiotopoulos, Paperback ISBN: 9780323901376, eBook ISBN: 9780323901383, 1st Edition – April 14, 2021, Elsevier.
3. Driverless: Intelligent Cars and the Road Ahead (MIT Press) 1St Edition, by Hod Lipson , Melba Kurmanr), ISBN-13: 978-0262035224, ISBN-10: 0262035227, September 23, 2016.).

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22EE52B2: AUTONOMOUS VEHICULAR TECHNOLOGY

L-T-P-S: 3-0-0-0 Credits: 3 Pre-Requisite: NIL

Mapping of Course Outcomes with PO/PSO:

CO#	Course Outcome	PO/PSO	BTL
1	Understand the the concepts of Autonomous Vehice Technology	1,3	2
2	Understand the concept of remote sensing and the types of sensor technology needed to implement remote sensing	1,3	2
3	Understand the concept of wireless standards and the fundamentals of on-board vehicle networks	1,6	2
4	Apply fundamentals of sensor data fusion as it relates to ADAS and Become familiar with modern vehicle display/cluster technology	2,3	3

Syllabus:

Introduction – SAE autonomous Level Classification-Examples-Application of Autonomous Vehicle Advantages and Disadvantages of Autonomous Vehicles.

Connected and Autonomous Vehicle Technology: Basic Control System Theory applied to Automobiles, Overview of the Operation of ECUs, Basic Cyber-Physical System Theory and Autonomous Vehicles, Role of Surroundings Sensing Systems and Autonomy, Role of Wireless Data Networks and Autonomy.

SENSORS, PERCEPTION AND VISUALISATION: Introduction to sensors, perception and visualisation for autonomous vehicles-Sensor integration architectures and multiple sensor fusion-AI algorithms for sensing and imaging-neural networks.

Wireless Networking and Applications to Vehicle Autonomy : Overview of wireless technology Basics of Computer Networking – the Internet of Things , Wireless Networking Fundamentals , Integration of Wireless Networking and On-Board Vehicle Networks, Review of On-Board Networks – Use & Function,

HUMAN FACTORS AND ETHICAL DECISION MAKING: Introduction to Human Factors-Human Performance: Perception and Attention-Situation Awareness and Error-Human Reliability: Driver Workload and Fatigue-Emotion and Motivation in Design-Trust in Autonomous Vehicles and Assistive Technology-Designing ADAS Systems-Driverless Vehicles and Ethical Dilemmas: Human Factors and Decision Making Software-Application of Human Factors in Autonomous Vehicles. International and national regulatory frameworks for CAV and their safe operation.

Text Books:

4. Autonomous Driving: How the Driverless Revolution will Change the World, by Andreas Herrmann, Walter Brenner, Rupert Stadler, ISBN-10 1787148343, ISBN-13 978-1787148345, Emerald Publishing Limited, 26 March 2018.
5. Autonomous Vehicles: Technologies, Regulations, and Societal Impacts, George Dimitrakopoulos, Aggelos Tsakanikas, Elias Panagiotopoulos, Paperback ISBN: 9780323901376, eBook ISBN: 9780323901383, 1st Edition – April 14, 2021, Elsevier.
6. Driverless: Intelligent Cars and the Road Ahead (MIT Press) 1St Edition, by Hod Lipson , Melba Kurmanr), ISBN-13: 978-0262035224, ISBN-10: 0262035227, September 23, 2016.).

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Dr JAR[illegible]SOMLAL

22EE52B3: Hybrid & Fuel Cell Vehicles

L-T-P-S: 3-0-0-0 **Credits: 3** **Pre-Requisite: NIL**

Mapping of Course Outcomes with PO/PSO:

CO#	Course Outcome	PO/PSO	BTL
1	Understand the basics of conventional vehicle and history of HEV	1,3	2
2	Discriminate various motors used for HEV	1,3	4
3	Identify various energy storage systems for HEV	1,6	2
4	Understand the function of EMS in HEV	2,3	2

Syllabus:

Introduction to Hybrid Electric Vehicles:

History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies. Hybrid Electric Drive-trains: Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency
analysis.

Electric Drive-trains: Basic concept of electric traction, introduction to various electric drive-train topologies, power flow control in electric drive-train topologies, fuel efficiency analysis.

Electric Propulsion unit: Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives, configuration and control of Permanent Magnet Motor drives, Configuration and control of Switch Reluctance Motor drives, drive system efficiency.

Energy Storage System: Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Super Capacitor based energy storage and its analysis, Flywheel based energy storage and its analysis, Hybridization of different energy storage devices. Sizing the drive system: Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selecting the energy storage technology, Communications, supporting subsystems

Energy Management Strategies: Introduction to energy management strategies used in hybrid and electric vehicles, classification of different energy management strategies, comparison of different energy management strategies, implementation issues of energy management strategies. **Case Studies:** Design of a Hybrid Electric Vehicle (HEV), Design of a Battery Electric Vehicle (BEV).

Text Books:

1. C. Mi, M. A. Masrur and D. W. Gao, "Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives", John Wiley & Sons, 2011.
2. S. Onori, L. Serrao and G. Rizzoni, "Hybrid Electric Vehicles: Energy Management Strategies", Springer, 2015.

References Books:

1. M. Ehsani, Y. Gao, S. E. Gay and A. Emadi, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design", CRC Press, 2004.
2. T. Denton, "Electric and Hybrid Vehicles", Routledge, 2016.
3. Iqbal Hussain, CRC Press, Taylor & Francis Group, Second Edition (2011).