

M.TECH. – POWER AND ENERGY (SMARTGRIDS AND ELECTRIC VEHICLES)

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

The restructuring and deregulation of electric utilities, along with rapid advancements in Smart Grids and Renewable Energy Technologies, have created unprecedented challenges and exciting opportunities for research in power and energy systems. These developments open new horizons for aspiring power engineers. The evolution of conventional power systems into Intelligent Power Grids—integrating cutting-edge technologies such as Smart Sensing, Cyber-Physical Systems, ICT, Renewable Energy Sources, Electric Vehicles, and Energy Storage—will play a crucial role in building a sustainable future. The M.Tech. program in Power and Energy is designed to address these emerging challenges and foster in-depth research in this dynamic domain. With a strong emphasis on lab-oriented courses, the program offers hands-on experience and insights into real-time systems, enabling students to develop a comprehensive understanding of modern energy infrastructures.

The curriculum spans a broad range of focus areas, including Smart Grids, Electric Vehicles, Power Systems, Sustainable and Renewable Energy, Applications of Computational and Communication Technologies, Power Electronics and Control, and Embedded Systems. This multidisciplinary approach prepares graduates for diverse career opportunities across sectors such as power and energy, smart grid technologies, electric mobility, communication systems, petroleum industries, energy management, and conservation. The program also aims to cultivate a passion for advanced research and innovation in these critical areas.

CURRICULUM

FIRST SEMESTER

Course Code	Type	Course	L-T-P	Credit
25MA602	FC	Numerical Computation and Optimization	3-1-0	4
25PR601	FC	Operation, Control, and Modernization of Electric Power Grids	3-1-0	4
25PR602	SC	Machine Learning and Artificial Intelligence	3-0-2	4
25PR603	SC	Electric Vehicle Technology	3-0-2	4
25PR604	FC	Power Converters and Drives	3-0-2	4
22ADM501		Glimpses of Indian Culture		P/F
23HU601		Career Competency I*	0 0 3	P/F
25AVP501		Mastery over Mind	1 0 2	2
		Credits		22

* Non-credit course; **L-T-P**: Lecture- Tutorial- Practical Hours

SECOND SEMESTER

Course Code	Type	Course	L-T-P	Credit
25PR611	SC	Sustainable and Renewable Energy Technology	3-0-2	4
25PR612	SC	Smart Power Grids	3-1-0	4
25PR613	SC	Vehicular Networks and Communications	3-0-2	4
	E	Elective 1	3-0-0	3
	E	Elective 2	3-0-0	3
25PR681	P	Application Development Lab	0-0-2	1
23HU611		Career Competency II	0-0-3	1
25RM605		Research Methodology	2-0-0	2
25PR698		Industry Internship	0-0-2	1
		Credits		23

THIRD SEMESTER

Course code	Type	Course	credit
25PR798	P	Dissertation I	11

FOURTH SEMESTER

Course code	Type	Course	credit
25PR799	P	Dissertation 2	14
		Total	70

LIST OF COURSES

Foundation Core (FC)

Course Code	Course	L – T – P	Credits
25MA602	Numerical Computation and Optimization	3-1-0	4
25PR601	Operation, Control, and Modernization of Electric Power Grids	3-1-0	4
25PR604	Power Converters and Drives	3-0-2	4

Subject Core (SC)

Course Code	Course	L – T – P	Credits
25PR602	Machine Learning and Artificial Intelligence	3-0-2	4
25PR603	Electric Vehicle Technology	3-0-2	4
25PR611	Sustainable and Renewable Energy Technology	3-0-2	4
25PR612	Smart Power Grids	3-1-0	4
25PR613	Vehicular Networks and Communications	3-0-2	4

ELECTIVES - GENERAL STREAM

Course Code	Course	L – T – P	Credits
25PR731	Digital Signal Controllers and Applications	3-0-0	3
25PR732	Cyber Security and Resilience in Smart Grid and Electric Vehicles	3-0-0	3
25PR733	Cyber Physical Systems	3-0-0	3
25PR734	Energy Storage Technology	3-0-0	3
25PR735	Smart sensors and IoT	3-0-0	3
25PR736	Control System Design	3-0-0	3
25PR737	System Engineering and Integration	3-0-0	3
25PR738	Generative and Reinforcement Learning for SmartGrid and EV Systems	3-0-0	3

ELECTIVES - POWER STREAM

Course Code	Course	L – T – P	Credits
25PR741	Advanced Optimization Techniques for Power System Applications	3-0-0	3
25PR742	Bio-Energy Conversion	3-0-0	3
25PR743	ICT enabled Power System Protection	3-0-0	3
25PR744	Mathematical Modelling of Energy Systems	3-0-0	3
25PR745	Solar Energy Utilization	3-0-0	3
25PR746	Wind Energy Conversion Systems	3-0-0	3
25PR747	Energy Conservation and Management	3-0-0	3

ELECTIVES – EV TECHNOLOGY STREAM

Course Code	Course	L – T – P	Credits
25PR751	Electric Vehicle Charging Infrastructure	3-0-0	3
25PR752	Hybrid and Electric Vehicles	3-0-0	3
25PR753	Automotive Embedded Systems and Control	3-0-0	3
25PR754	Vehicle Dynamics and Control	3-0-0	3
25PR755	Automotive Electronics	3-0-0	3
25PR756	E-mobility Business and Policies	3-0-0	3
25PR757	Industry Trends in Automotive Electrification- Valeo Germany	3-0-0	3

Project Work

Course Code	Course	L – T – P	Credits
25PR681	Application Development Lab	0-0-2	1
25PR798	Dissertation I		11
25PR799	Dissertation II		14

Program Outcomes

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.

Program Specific Outcomes

PSO1: Ability to use advanced techniques, skills, and modern scientific and engineering tools for professional practice.

PSO2: Developing professional competence and leadership qualities with a harmonious blend of moral and ethical values.

25MA602**NUMERICAL COMPUTATION AND OPTIMIZATION****3-1-0-4****Course Outcome:**

CO1	Illustrate various numerical methods for solving linear and nonlinear equations.
CO2	Apply various numerical integration and differentiation techniques to obtain approximate solutions to mathematical problems.
CO3	Apply various numerical methods for solving differential equations.
CO4	Illustrate and apply different types of Optimization Techniques in unconstrained/ constrained engineering problems.
CO5	Ability to use software tools in implementing numerical methods and optimization algorithms for real world engineering problems.

Course Articulation Matrix: Correlation level [1: low, 2: medium, 3: High]

PO	PO1	PO2	PO3	PSO1	PSO2
CO					
CO1	2	-	3	1	-
CO2	2	-	3	1	-
CO3	2	-	3	1	-
CO4	2	-	3	1	-
CO5	2	2	2	3	-

Linear equations: Error analysis for Iterative Methods, System of linear equations and solution finding by Gaussian elimination, Gauss-Jordan iterative methods for solving system of linear equations, applications to state estimation in power systems, Eigen value and eigen vector problems, solution by power method, application of Small-signal stability via eigenvalue analysis.

Non-Linear equations: Bisection method, least squares method, Newton's method, application to battery discharge curve modelling and harmonic estimation.

Numerical differentiation and integration: Using Taylor series to derive difference formulas, Trapezoid method, application to power and energy computation.

Differential Equations: Initial value problems for ordinary differential equations: single step methods, Taylor series method, Euler, and modified Euler methods. Fourth order Runge - Kutta method for solving first and second order equations. Application to Induction Motor Speed Transient analysis.

Unconstrained one-dimensional optimization techniques: Necessary and sufficient conditions. Solution using bracketing methods: exhaustive search method, bounding phase method, Gradient based method.

Unconstrained n-dimensional optimization techniques: Direct search methods, random search, descent methods, steepest descent, conjugate gradient. Simulation in different power and energy system optimization problems.

Constrained optimization techniques: necessary and sufficient conditions, equality and inequality constraints, Kuhn-Tucker conditions, Lagrangian multiplier method, penalty function method. applications in power and energy systems.

TEXTBOOKS/ REFERENCES:

1. Richard L. Burden, J. Douglas Faires, and Annette M. Burden, "Numerical Analysis", 10th Edition, Cengage Learning, 2015.
2. S. S. Rao, "Engineering Optimization Theory and Practice", 5th edition, John Wiley and Sons, 2020.
3. Steven Chapra and Raymond Canale, "Numerical Methods for Engineers", 8th edition, McGraw-Hill, 2021.
4. W. Cheney and D. Kincaid, "Numerical Mathematics and Computing", 7th edition, Cengage Learning, 2013.
5. T. Sauer, Numerical Analysis, 3rd Edition, Pearson, 2017.
6. Gerald C. F. and Wheatley P. O, "Applied Numerical Analysis", 7th Edition, Pearson Education India, 2007.

25PR601 OPERATION, CONTROL, AND MODERNIZATION OF ELECTRIC POWER GRIDS 3-1-0-4**Course Outcome**

CO1	Model and analyze electric power grids for load flow, economic dispatch, and state estimation.
CO2	Evaluate power system stability, control strategies, and power quality issues under various operating conditions.
CO3	Analyze the drivers and technologies of grid modernization, including distributed energy resources and smart grids.
CO4	Interpret real-world power system scenarios through simulation-based experiments and case studies.

Course Articulation Matrix: Correlation level [1: low, 2: medium, 3: High]

PO	PO1	PO2	PO3	PSO1	PSO2
CO					
CO1	2	-	3	-	-
CO2	2	-	3	-	-
CO3	2	-	3	-	-
CO4	2	2	3	1	1

Analysis, Operation and Control of Electric power grids: Network modelling, Load flow analysis, Economic operation, State estimation, Power system control and stability, SCADA functions, Power quality.

Modernization of Electric power grids: Grid modernization drivers, Distributed Energy Resources (DERs), Evolution of microgrids and smart grids, Electrification, Digitalization, Benefits of grid modernization.

Simulation/software experiments and case studies.

TEXT BOOKS/ REFERENCES:

1. Allen J. Wood and Wollenberg B.F., "Power Generation Operation and Control", Wiley 3rd Edition, 2013.
2. Olle I. Elgerd, "Electric Energy and System Theory – An Introduction", Tata McGraw-Hill Publishing Company Limited, New Delhi, 2nd Edition, 2017.
3. Monticelli, "Electric Power System State Estimation", Proc. IEEE, Vol. 88, No.2, 2000.
4. Nagrath, I.J. and Kothari D.P., "Modern Power System Analysis", TMH, New Delhi, 2006.
5. Kirchmayer L.K., "Economic Control of Interconnected Systems", John Wiley & Sons, 1959.
6. N. V. Ramana, "Power System Operation and Control", Pearson, 2011.
7. Belu, Radian. Smart Grid Fundamentals: Energy Generation, Transmission, and Distribution. United States, CRC Press, 2022.
8. Jack Patterson, "Power Grid Modernization". Norway, Publifye AS, 2025.
9. Prabha S. Kundur, "Power System Stability and Control", McGraw-Hill Education, 2nd Edition, 2022.
10. Arillaga, N.R. Watson and S.Chen, "Power System Quality Assessment", John Wiley & Sons, England, 2000.
11. K.R. Padiyar, "Power System Dynamics: Stability and Control", John Wiley & Sons, 2008.

25PR602 MACHINE LEARNING AND ARTIFICIAL INTELLIGENCE 3-0-2-4

Course Outcome:

CO1	Apply the concepts of supervised and unsupervised machine learning algorithms
CO2	Apply artificial neural networks and fuzzy inference systems to solve problems involving uncertainty and pattern recognition
CO3	Analyze search algorithms and reinforcement learning techniques for intelligent decision-making
CO4	Demonstrate the application of machine learning and AI in Smart grids and electric vehicles

Course Articulation Matrix: Correlation level [1: low, 2: medium, 3: High]

PO	PO1	PO2	PO3	PSO1	PSO2
CO					
CO1	1	1	2		
CO2	2	1	2		
CO3	2	1	3		
CO4	3	1	3	3	1

Introduction to statistics and Data preprocessing. Dimensionality reduction techniques, Machine Learning for classification and regression: Supervised Learning, Linear Regression, Logistic Regression, Support Vector Machine, Tree Models, Naïve Bayes, Ensemble Learning; Unsupervised Learning-Clustering

Introduction to Neural Networks, MLPs, Deep Neural Networks: architecture and transfer learning, Recurrent Neural Networks. Fuzzy Inference System, Neuro-Fuzzy.

Search algorithm: Depth first search, Breadth first search, A-star Algorithm.

Reinforcement Learning: Classical Reinforcement Learning methods.

Hyper-parameter tuning, Model Evaluation Metrics.

Case study/Coding Lab for Applications in SmartGrid and Electric Vehicles

TEXTBOOK/REFERENCES

1. Christopher Bishop, "Pattern Recognition and Machine Learning", Second edition Springer New York, 2016.
2. Tom M. Mitchell, "Machine Learning", McGraw Hill India, 2017
3. Andreas C. Müller, and Sarah Guido, "Introduction to Machine Learning with Python" O'Reilly Media publishers, October 2016.
4. Russell, S. and Norvig, P., "Artificial Intelligence - A Modern Approach", 4th edition, Pearson, 2021.
5. Selected transactions on applications of machine learning, artificial intelligence in Electric vehicles and Smart grids

25PR603

ELECTRIC VEHICLE TECHNOLOGY

3-0-2-4

Course Outcome:

CO1	Illustrate the architecture, drivetrain configurations, and fundamental vehicle dynamics of electric and hybrid electric vehicles
CO2	Design and evaluate suitable electric and hybrid vehicle drive schemes based on available energy sources, drive cycle requirements, and vehicle performance objectives.
CO3	Analyze energy storage systems, charging infrastructure technologies and their standards.
CO4	Demonstrate the application of machine learning and AI in Smart grids and electric vehicles

Course Articulation Matrix: Correlation level [1: low, 2: medium, 3: High]

PO	PO1	PO2	PO3	PSO1	PSO2
CO					
CO1	2	1	3	1	-
CO2	2	1	3	2	-
CO3	2	1	3	2	-
CO4	2	1	3	2	-

Review of Conventional Vehicle, Types of EVs, Architecture and concepts of hybrid electric power trains. Vehicle Dynamics, Tractive Effort & Analysis, Energy Storage Requirements in Electric Vehicles, Types of energy storage technologies for EV, Charging and discharging characteristics: Battery Management System, Cell balancing, Pre-charge circuit. Battery Swapping Technologies, Thermal Management in EV battery. EV charging standards, V2X and enabling technologies. Electric Propulsion systems: EV Motor drives, Configuration and control of Drives and Sizing. Energy Management Strategies, Vehicle Testing and Validation-MIL, SIL, HIL, VIL, E-mobility business, and electrification challenges. Connected Mobility and Autonomous Mobility. Case study/Simulation/Hardware experiments.

TEXTBOOKS/ REFERENCES:

1. Emadi, A. (Ed.), Miller, J., Ehsani, M., "Vehicular Electric Power Systems" Boca Raton, CRC Press, 2003.

2. K E M Ehsani, Y Gao, S Longo, *Modern Electric, Hybrid Electric, and Fuel Cell Vehicles*, CRC Press, 3rd Edition, 2019
3. Husain, I. *“Electric and Hybrid Vehicles: Design Fundamentals”* 3rd Edition, Taylor and Francis, 2021)
4. Larminie, James, and John Lowry, *“Electric Vehicle Technology Explained”* John Wiley and Sons, 2012.
5. Tariq Muneer and Irene Illescas Garcia, *“The automobile, In Electric Vehicles: Prospects and Challenges”*, Elsevier, 2017.
6. Sheldon S. Williamson, *“Energy Management Strategies for Electric and Plug-in Hybrid Electric Vehicles”*, Springer, 2013

25PR604

POWER CONVERTERS AND DRIVES

3-0-2-4

Course Outcome:

CO1	Analyze the principles of power electronics and drives, including DC-DC converters, inverters, and PWM techniques
CO2	Evaluate power conversion systems for smart grids and electric vehicles
CO3	Analyze the motor control strategies for electric vehicles and Smartgrid.
CO4	Design and evaluate power electronics techniques to real-world case studies focusing on smartgrid and Electric vehicle applications,

Course Articulation Matrix: Correlation level [1: low, 2: medium, 3: High]

PO					
CO	PO1	PO2	PO3	PSO1	PSO2
CO1	1				
CO2	2		3		
CO3	2		3		
CO4	3	2	2	2	

Review of DC-DC converters, inverters, Switch Mode power Supplies, PWM techniques. Power Converters and drives for Smart Grid and EV: Grid-connected inverters- synchronization, anti-islanding, PLL techniques; PE interface for solar, wind, and hybrid sources; Energy Storage interfacing using bidirectional converters. Onboard and offboard charging architecture in EV, Bidirectional chargers for Vehicle-to-Grid (V2G) systems, Powertrain design and energy flow in EVs; Drive control strategies- DC Motor, Induction Motor (IM), Permanent Magnet Synchronous Motor (PMSM), Brushless DC Motor (BLDC); Field Oriented Control (FOC), Direct Torque Control (DTC), Regenerative braking and torque control.

Case Studies and Emerging Applications.

TEXTBOOKS/REFERENCES:

1. Dharavath Kishan, Ramani Kannan, et al. *Power Electronics for Electric Vehicles and Energy Storage: Emerging Technologies and Developments*, CRC Press, 2023
2. Bimal K Bose, *Power Electronics in Renewable Energy Systems and Smart Grid: Technology and Applications*, Wiley, 2019.
3. Iqbal Hussain, *“Electric and Hybrid Electric Vehicle’s Design Fundamentals”*, Second Edition, CRC Press, 2010.
4. R. Krishnan, *“Electric Drives: Modelling, Analysis and Control”*, PHI, 2007.
5. Joseph Vithayathil, *“Power Electronics, Principles and Applications”*, McGraw Hi Series. 6th Reprint, 2013.
6. Vedam Subramaniam, *“Electric Drives: Concepts and Applications”*, Tata McGraw Hill, 2011.

25PR611 SUSTAINABLE AND RENEWABLE ENERGY TECHNOLOGY 3-0-2-4**Course Outcome:**

CO1	Evaluate the challenges of energy sustainability and the impact of global energy policies.
CO2	Analyze the performance and applications of solar and wind energy systems
CO3	Assess emerging renewable energy sources and energy storage systems for their role in sustainable energy solutions.
CO4	Evaluate the performance of renewable energy systems by conducting hardware/simulations/ case studies

Course Articulation Matrix: Correlation level [1: low, 2: medium, 3: High]

PO	PO1	PO2	PO3	PSO1	PSO2
CO					
CO1	2	2	1	-	-
CO2	2	-	3	-	-
CO3	3	-	2	-	-
CO4	3	2	2	3	-

Energy Sustainability- Challenges and Future Technologies: Challenges in energy sustainability, Clean/Green Energy Technologies. International agreements/conventions on Energy and Sustainability: United Nations Framework Convention on Climate Change (UNFCCC), Sustainable Development Goals: SDG 7- Affordable and Clean Energy

Solar Energy: Solar radiation measurements, Effects of changes in tilt angle, Modelling of PV cell, Effects of shaded and faulty cell, Maximum power tracking, Charge Controllers, MPPT Algorithms, Stand Alone PV and Grid Connected PV System, Hybrid Systems, Advanced solar technologies, National Solar Mission.

Wind energy: Wind monitoring and resource assessment, Characteristics and modelling of wind turbines, Power regulations, configurations and working principle of wind energy conversion system, Offshore wind energy systems, Standalone/Grid connected applications.

Alternative Renewable Energy Technologies: Biomass-Gasifiers, Small hydro, wave, tidal, ocean thermal, and geothermal. Energy storage: Principles of Battery, Supercapacitor, Fuel cells, its operation, types, applications. Hybrid Renewable parks.

Hardware/simulation experiments/case study on Renewable Energy Systems.

TEXTBOOKS/REFERENCES:

1. *World Energy Assessment: Energy and the Challenge of Sustainability*, United Nations Development Programme (UNDP), New York, 2000.
2. Roger A. Messenger, Homayoon Amir Abtahi, *Photovoltaic Systems Engineering*, CRC Press, 2024.
3. J. F. Manwell, J. G. McGowan, A. L. Rogers, *Wind Energy Explained: Theory, Design and Application*, John Wiley & Sons, Ltd, 2010.
4. Chetan S. Solanki, "Solar Photovoltaics: Fundamentals, Technologies And Applications", 3rd Edition, PHI Publications, 2015.
5. Qiuwei Wu (Editor), Yuanzhang Sun (Editor), *Modeling and Modern Control of Wind Power* (IEEE Press), Wiley-IEEE Press, 2018.

Course Outcome:

CO1	Illustrate the structure, components, and operational principles of microgrids and smart grids, and differentiate their roles in conventional and modern power systems.
CO2	Analyse the application of communication protocols, network structures, and real-time monitoring technologies used in smart grid operations.
CO3	Evaluate the role of smart sensing technologies in enhancing grid operation and performance.
CO4	Assess clean energy technologies and power electronics interfaces in smart grid.
CO5	Design and develop Smart grid concepts in realizing systems for practical applications.

Course Articulation Matrix: Correlation level [1: low, 2: medium, 3: High]

PO	PO1	PO2	PO3	PSO1	PSO2
CO					
CO1	3	1	2	2	1
CO2	3	1	3	1	1
CO3	2	1	3	2	1
CO4	3	2	1	1	1
CO5	2	1	3	1	1

Smart grid Overview and Components: Smart grid landscape and its characteristics, smart grid architecture, Smart grid scenario in Indian power sector, National Smart Grid Mission (NSGM), FAME India Scheme and International frameworks

Key Concepts in Smart grid Operations & Control – Distributed Intelligence, Self-Healing Protection, Distributed Generation/ DER, Demand side management, Demand Response, Advanced metering infrastructure (AMI), Energy Storage and Management systems -HEMS/BEMS, Automation and Control-SCADA, Power system economics, Smart Grid Markets and Operations, Energy Trading, Energy Security. Clean Energy and Power Electronics Interface - Energy sustainability, Renewable Energy Integration, G2X, Power Quality in Smart grid. IEEE/IET Standards, Resilient Grids-Climate-resilient designs, Microgrid-based disaster recovery, Adaptive infrastructure.

Communications and Networks in Smart grid: Wired and wireless communication technologies, smart grid protocols, Network Structures, Smart sensing, Smart Metering, Phasor Measurement Units, IED, AMI communication, WAMS, Geographical Information System.

TEXTBOOKS / REFERENCES:

1. Ali Keyhani, "Design of Smart Power Grid Renewable Energy Systems", John Wiley & Sons, IEEE Press 2011.
2. James Momoh, "Smart Grid - Fundamentals of Design and Analysis", John Wiley & Sons, IEEE Press 2012.
3. Andres Carvello, John Cooper, "The Advanced Smart Grid", ARTECH House, 2011
4. Janaka Ekanayake, Kithsiri Liyanage, Jianzhong Wu, Akihiko Yokoyama, and Nick Jenkins, "Smart Grid: Technology and Applications", Wiley, New Delhi, Aug 2015.
5. Lars T. Berger and Krzysztof Iniewski, "Smart Grid Applications, Communications, And Security," Wiley, New Delhi, Aug 2015
6. Tomar, A., and R. Kandari (Eds.), "Advances in Smart Grid Power System: Network, Control and Security", Academic Press (Elsevier), UK, 2020.
7. Buchholz, B. M., and Z. A. Styczynski, "Smart Grids: Fundamentals and Technologies in Electric Power Systems of the Future," Second Edition, Springer Nature, 2020.
8. Sioshansi, F. (Ed.), "Smart Grid: Integrating Renewable, Distributed and Efficient Energy," Academic Press, 2011.

Course Outcome:

CO1	Analyze the architecture and key components of transportation and vehicular networks
CO2	Evaluate the effectiveness of various V2X communication technologies.
CO3	Examine the intra-vehicular communication systems.
CO4	Assess the performance and practical implementation of vehicular networks and communication technologies focusing on their real-world applications and effectiveness in intelligent transportation systems.

Course Articulation Matrix: Correlation level [1: low, 2: medium, 3: High]

PO	PO1	PO2	PO3	PSO1	PSO2
CO					
CO1	2		2		
CO2	2		2	2	
CO3	2		2	2	
CO4	3	3-	3	3	1

Introduction to Vehicular Networks -Overview of Intelligent Transportation Systems (ITS), fundamentals of Vehicular Ad Hoc Networks (VANETs), overview of V2X communication types, characteristics of vehicular networks.

Communication Technologies for V2X: IEEE 802.11p and DSRC standards, Cellular V2X (C-V2X) hybrid V2X architectures, millimeter wave (mmWave) communication, and Visible Light Communication (VLC) in vehicular environments.

Intra-Vehicular Communication and Bus Systems: Requirements and classification of in-vehicle bus systems, CAN, CAN-FD, LIN, FlexRay, MOST, Bluetooth, and Automotive Ethernet, Network Coupling and Gateways, AUTOSAR Platforms: Classic vs Adaptive, Communication Stack; Real-time automotive applications (ADAS, EVs).

Vehicular Network Models: VANET, WAVE, Vehicular Cloud, Internet of vehicles.

Data management and Cloud integration in vehicular network, Security and Privacy in Vehicular Networks, Case studies and application in vehicular network and Intelligent transport system.

TEXTBOOKS/REFERENCES:

1. Stephan Olariu , Michele C. Weigle Vehicular Networks: From Theory to Practice (Chapman & Hall/CRC Computer and Information Science Series), 2017.
2. IAnand Paul, Naveen Chilamkurti, Alfred Daniel, Seungmin Rho, Intelligent Vehicular Network and Communications: Fundamentals, Architectures and Solutions, Elsevier, 2017.Vehicular Networking: Automotive Applications and Beyond
3. Hassnaa Moustafa, Yan Zhang, Vehicular Networks: Techniques, Standards, and Applications, 2019.
4. *IEEE Transactions and other journals*
5. Dominique Paret, "Multiplexed Networks for Embedded Systems: CAN, LIN, Flex Ray, Safe-by-Wire", Wiley, 2007.
6. Xiang W, "Wireless Access in Vehicular Environments Technology", Springer, 2015.
7. C. Sommer, F. Dressler, Vehicular Networking, Cambridge University Press, 2015.
8. M. Watfa, Advances in Vehicular Ad-Hoc Networks: Development and Challenges, Information Science Reference, 2010.

Course Outcome:

CO1	Utilize appropriate simulation platforms for modeling, analysis, and design of electrical systems
CO2	Review existing literature to identify research gaps and define a focused problem statement within the domain of study
CO3	Formulate a research hypothesis and design a methodology to address the identified problem
CO4	Develop, simulate, and validate an effective model-based solution to the research problem

Course Articulation Matrix: Correlation level [1: low, 2: medium, 3: High]

PO	PO1	PO2	PO3	PSO1	PSO2
CO					
CO1	3	2	3	2	3
CO2	3	3	3	2	1
CO3	3	2	3	1	1
CO4	3	2	3	1	1

Familiarize simulation tools like MATLAB, ETAP, LABVIEW, PSCAD, etc.

The student, in consultation with the Thesis Advisor, must select a topic related to the domain of study and should work for the thesis phase. Literature Review, Identification of Research Problem, Proposal of Research Hypothesis, Simulation, Model Design, and Development of Solution for the Research Problem

Course Outcome

CO1	Develop a foundational understanding of research methodologies and their applications.
CO2	Identify and define research problems through structured problem formulation techniques.
CO3	Design and conduct experimental research with appropriate tools and analysis methods.
CO4	Prepare for dissertation writing by organizing research findings and adhering to academic standards.
CO5	Demonstrate awareness of intellectual property rights and their relevance in research and innovation.

Course Articulation Matrix: Correlation level [1: low, 2: medium, 3:High]

PO	PO1	PO2	PO3	PSO1	PSO2
CO					
CO1	2	2	1	1	1
CO2	2	3	3	2	2
CO3	2	2	3	2	1
CO4	2	2	1	1	1
CO5	2	2	2	1	1

Meaning and objectives of research, characteristics of good research, types of research. Research process: research gap identification, problem formulation, scope definition, objective setting, research questions and hypotheses, research design. Approaches to research, building and validating theoretical models, importance of reasoning in research, literature review, critical analysis, sampling techniques, data collection methods, data acquisition tools, modeling and simulation, sensitivity analysis, uncertainty modeling, statistical tools, measurement systems analysis

Technical writing – components of research paper/thesis, citation styles, referencing and plagiarism detection tools, poster/oral presentation, conference/journal paper preparation, project proposal writing. Intellectual Property Rights (IPR) – patents, copyrights, trademarks, industrial designs, geographical indications, research ethics – scientific misconduct, plagiarism, unscientific practices, authorship norms. Review of high-impact papers in the domain of study, dissertation planning – milestones, expected outcomes, real-world case studies.

TEXT BOOKS/ REFERENCES:

1. Bordens, K. S. and Abbott, B. B., “Research Design and Methods – A Process Approach”, 8th Edition, McGraw-Hill, 2011.
2. C. R. Kothari, “Research Methodology – Methods and Techniques”, 2nd Edition, New Age International Publishers
3. Davis, M., Davis K., and Dunagan M., “Scientific Papers and Presentations”, 3rd Edition, Elsevier Inc.
4. Michael P. Marder, “Research Methods for Science”, Cambridge University Press, 2011
5. T. Ramappa, “Intellectual Property Rights Under WTO”, S. Chand, 2008
6. Robert P. Merges, Peter S. Menell, Mark A. Lemley, “Intellectual Property in New Technological Age”. Aspen Law & Business; 6th edition July 2012

25PR698

INDUSTRY INTERNSHIP

0-0-2-1

Course Outcome

CO1	Demonstrate awareness of the operational structure, culture, and practices of an industrial or research environment.
CO2	Apply theoretical knowledge to analyze and solve practical problems in a professional setting.
CO3	Develop and deliver well-structured technical documentation and presentations based on project or internship work

Course Articulation Matrix: Correlation level [1: low, 2: medium, 3:High]

PO	PO1	PO2	PO3	PSO1	PSO2
CO					
CO1	2	-	1	2	3
CO2	2	-	1	2	3
CO3	-	3	-	-	-

Students must undergo a minimum of two weeks of practical training in Smart Grids, Energy Systems, Renewable Energy, Electrical Vehicles, Embedded Systems, Power Electronics, Drives or industries/research laboratory of their choice with the approval of the department. At the end of the training student should submit a report and certificate of completion to the department in the prescribed format.

Course Outcome:

CO1	Identify and analyze an engineering problem, and develop a proof of concept using suitable methods.
CO2	Plan and manage time, cost, and resources while adhering to ethical and professional standards.
CO3	Work effectively to execute the project with environmental and social responsibility
CO4	Communicate findings clearly through written reports, presentations, and visual aids

Course Articulation Matrix: Correlation level [1: low, 2: medium, 3: High]

PO					
CO	PO1	PO2	PO3	PSO1	PSO2
CO1	3	1	3	3	2
CO2	2	1	2	2	3
CO3	2	1	2	1	3
CO4	1	3	2	1	2

Course Outcome:

CO1	Gain insights into the architecture of Digital Signal Controllers.
CO2	Analyze the various peripherals associated with Digital Signal Controllers.
CO3	Design Digital Signal Controllers based applications

Course Articulation Matrix: Correlation level [1: low, 2: medium, 3: High]

PO					
CO	PO1	PO2	PO3	PSO1	PSO2
CO1	2	-	-	1	-
CO2	1	-	1	2	-
CO3	-	1	1	3	1

Digital Signal controllers: Introduction, file registers, memory organization, interrupts, peripherals: Ports, Timer, ADC, PWM, Communication protocols: CAN. Redundancy and safety features of DSCs: multi-core architecture, error detection and correction features, sensor fusion. Signal generation: PWM, SPWM and servo signals. Filtering algorithms: FIR filters, IIR filters. Control Algorithms: P, PI, PID controllers, Fourier Transforms: DFT, FFT, DCT algorithms.

Simulation/hardware experiments with latest digital signal controllers.

TEXTBOOKS/ REFERENCES:

1. *dsPIC30F Family Reference Manual*, 2017 Microchip Technology Inc., DS70046E.
2. *STM32 Reference manual*, ST Electronics, 2021.
3. *TMS320F2837xD Dual-Core Real-Time Microcontrollers Technical Reference manual*, Texas Instruments, 2024.
4. *MSP430F2xx, MSP430G2xx Family User's Guide*, Texas Instruments, 2022.
5. *dsPIC33/PIC24 Family Reference Manual*, Microchip Technology, 2013
6. John G Proakis, G. Manolakis, "Digital Signal Processing Principles, Algorithms, Applications", Prentice Hall India Private Limited, Fourth Edition, 2007.
7. Rulph Chassaing, Donald Reay, "Digital Signal Processing and Applications with TMS320Cxxx", Second Edition.2012.

Course Outcome:

CO1	Gain insights into the fundamental concepts and components of Cyber Security and Network systems.
CO2	Examine core security primitives specific to cyber-physical systems and apply them to address current and emerging security challenges.
CO3	Design, simulate and solve smart grid cyber security issues

Course Articulation Matrix: Correlation level [1: low, 2: medium, 3: High]

PO	PO1	PO2	PO3	PSO1	PSO2
CO					
CO1	3	2	1	1	1
CO2	2	2	2	1	1
CO3	2	2	2	1	1

Cyber Security: Fundamentals of Cyber Security, Cyber security principles, CIA Triad, Fundamentals of cryptography, Cyber security standards and frameworks, Threat Identification, Intrusion and Attack Detection, Encryption and Decryptions, Common types of Cyber-attacks; Malware attacks, Phishing, Brute forcing, Basics of Ethical Hacking .Network Systems: Network systems, Basics of Networking; Switches, Routers, Modems and wireless access points, Network connectivity, Internet Protocols, VPN, DNS, IP addresses Operating systems, Wireless Networking, Network and Data security, Co-simulation .

Smart Grid Cyber security: Smart grid cyber-physical systems, smart grid interoperability standards, Smart grid cyber networked standards, new Intelligent Electronic Devices (IED), Role of IoT and ML in Smart Grid Cyber Security , Federated learning in smart grid cyber resilience, , Smart grid cyber security issues, and challenges, Cyber-attacks in smart grids, Manmade and natural large scale disturbances; FDIA, Relay Attacks, Replay Attacks, Anomaly detection, and Rare event classification, Cyber resilience, FDIR, security solutions for smart grid, Risk and vulnerability assessment in smart grids. Attack probability analysis in smart grids, real-time network monitoring Cyber security in Electric Vehicles. Case study:, simulation experiments

TEXTBOOK/REFERENCES

1. Greer C, Wollman DA, Prochaska DE, et al. "Nist framework and roadmap for smart grid interoperability standards", release 3.0, No. Special Publication (NIST SP)-1108r3, 2014.
2. Al-Shaer E, Rahman MA, "Security and resiliency analytics for smart grids". Advances in Information Security, 2016.
3. Edward J. M. Colbert, Alexander Kott, "Cyber-security of SCADA and Other Industrial Control Systems" (Advances in Information Security Book 66), 2016.
4. Eric D. Knapp, Raj Samani, Applied Cyber Security and the Smart Grid, Syngress Publication., Imprint of Elsevier. 2013

Course Outcome

CO1	Gain insight into the basics of cyber-physical systems
CO2	Design and develop different controllers for the systems
CO3	Evaluate and apply advanced techniques for analysis of cyber physical systems
CO4	Explore different simulation software platforms for cyber-physical systems.

Course Articulation Matrix: Correlation level [1: low, 2: medium, 3: High]

PO	PO1	PO2	PO3	PSO1	PSO2
CO					
CO1	3	2	1	1	1
CO2	2	2	2	1	1
CO3	2	2	2	1	1
CO4	3	1	2	2	1

Cyber-Physical Systems (CPS) in the real world, Basic principles of design and validation of CPS, CPS HW platforms: Processors, Sensors, Actuators, CPS Network, CPS SW stack RTOS, Scheduling Real Time control tasks. Principles of Automated Control Design: Dynamical Systems and Stability, Controller Design Techniques. Stability Analysis, Performance under Packet drop and Noise. CPS : From features to software components, Mapping software components to ECUs, CPS Performance Analysis, Formal Methods for Safety Assurance of Cyber-Physical Systems: Advanced Automata based modelling and analysis, Formal Analysis, Analysis of CPS Software, Weakest Pre-conditions, Bounded Model checking, Hybrid Automata Modelling, CPS SW Verification, Secure Deployment of CPS: Attack models, Attack Detection and Mitigation in CPS, Secure Task mapping and Partitioning, State estimation for attack detection, Automotive Case study: Vehicle ABS hacking, Power Distribution Case study: Attacks on Smart grid, Drone Swarm coordination. Digital Twin Technology in Smart Grids and Electric Vehicles (EVs):

TEXTBOOKS/ REFERENCES:

1. E. A. Lee and S. A. Seshia, "Introduction to Embedded Systems: A Cyber-Physical Systems Approach," 2011.
2. R. Alur, "Principles of Cyber-Physical Systems," MIT Press, 2015.
3. T. D. Lewis "Network Science: Theory and Applications," Wiley, 2009.
4. P. Tabuada, "Verification and control of hybrid systems: a symbolic approach," Springer-Verlag 2009.
5. C. Cassandras, S. Lafortune, "Introduction to Discrete Event Systems," Springer 2007.
6. Constance Heitmeyer and Dino Mandrioli, "Formal methods for real-time computing," Wiley

25PR734**ENERGY STORAGE TECHNOLOGY****3-0-0-3****Course Outcome**

CO1	Illustrate the importance of the energy storage technology in power system
CO2	Analyze the function of each storage technology and its characteristics
CO3	Evaluate energy storage applications in Renewable energy systems, Electric vehicles and in Smart grid.
CO4	Design energy storage devices for energy management and analyze its cost effectiveness

Course Articulation Matrix: Correlation level [1: low, 2: medium, 3: High]

PO	PO1	PO2	PO3	PSO1	PSO2
CO					
CO1	-	-	1	-	-
CO2	1	-		-	-
CO3	2	-	2	-	-
CO4	-	-	1	3	-

Introduction to energy storage for power systems: Need and role of energy storage systems in power systems, applications, general considerations, Energy and power balance in a storage unit, Mathematical model of storage

Overview on Energy storage technologies: Potential energy (Pumped hydro, Compressed Air,) - Kinetic energy (Mechanical- Flywheel) Electrochemical energy (Batteries, Fuel cells) - Electrostatic energy (Super Capacitors), Electromagnetic energy (Superconducting Magnetic Energy Storage) - Different Types of Energy Storage Systems comparative analysis, Comparison of environmental impacts for different technologies.

Smart Grid and Electric Vehicle Storage Technology: Micro-grid/Smart Grid with SPV, Wind Energy, Fuel cell, Hydrogen, Battery Energy Storage with BMS, Balancing methods for battery pack: Active balancing and passive balancing, Battery Module & Pack Design, Battery management algorithms, Battery SCADA,

Hybrid Energy storage systems: configurations and applications, Improved Battery Technologies for Electric Vehicle- commercialized battery technologies, Second-life batteries Advanced batteries for EV Protection, cost analysis of EV batteries.

TEXTBOOKS & REFERENCES

1. Tony Burton, David Sharpe, Nick Jemkins and Ervin Bossanyi., "Wind Energy HandBook", John Wiley & Sons, 2004.
2. Chetan S. Solanki, "Solar Photovoltaics: Fundamentals, Technologies and Applications", Second Edition, PHI Publications, 2011
3. Xisheng Tang, Zhiping Qi, Li Kong, "Electrical Energy Storage Technologies and Applications", Springer Singapore (2025), ISBN: 9789819656240
4. Andrei G. TerGazarian, "Energy Storage for Power Systems", Institution of Engineering and Technology (IET), 18 June 2020, 3rd edition

25PR735

SMART SENSORS AND IoT

3-0-0-3

Course Outcome:

CO1	Analyze the working principles and signal conditioning techniques of sensors, actuators, and transducers used in intelligent systems
CO2	Evaluate the architecture, fabrication, and communication standards of smart sensors
CO3	Apply IoT architecture and communication models to design solutions for real time scenario.
CO4	Assess real-world applications of smart sensor and IoT technologies

Course Articulation Matrix: Correlation level [1: low, 2: medium, 3: High]

PO	PO1	PO2	PO3	PSO1	PSO2
CO					
CO1	2	2	3	3	1
CO2	2	2	3	3	1
CO3	2	2	3	3	2
CO4	3	3	3	2	2

Review of Sensors, actuators, transducers and Signal Conditioning

Introduction to Smart Sensor, Types and Technologies, General Architecture of smart sensor, Fabrication of Smart Sensor, Importance and Adoption of Smart Sensor, Smart Sensor Networking: 7-Layer OSI model of communication system, device-level networks. Smart Sensor Interface: Standard IEEE 1451, I/O techniques, Interfacing of I/O devices, Silicon Technology in Smart Sensor, Future Trends: Neurosensors; Biosensors, Nano-technology

Introduction to IoT, IoT value chains and an emerging industrial structure for IoT, Devices and gateways, Local and wide area networking, IoT Reference Architecture: Introduction, Functional view, Information view, Deployment and operational view. Real-world design constraints- Introduction, Data representation and visualization, Interaction and remote control, Service-oriented architecture-based device integration, SOCRADES: realizing the enterprise integrated Web of Things, IMC-AESOP: from the Web of Things to the Cloud of Things.

Case study related to Smart Grid and EV application

TEXTBOOKS & REFERENCES

1. Gerard C. M. Meijer M.Sc., Ph.D., *Smart Sensor Systems*, Wiley & Sons, Ltd, 2008
2. Brojo Kishore Mishra (Editor), Sandipan Mallik (Editor), Dac-Nhuong Le (Editor), *Smart Sensors for Industry 4.0: Fundamentals, Fabrication and IIoT Applications (Advances in Learning Analytics for Intelligent Cloud-IoT Systems)*, 2025
3. Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stefan Avesand, Stamatis Karnouskos, David Boyle, *“From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence”*, 1st Edition, Academic Press, 2014.
4. Vijay Madiseti and Arshdeep Bahga, *“Internet of Things (A Hands-on-Approach)”*, 1st Edition, VPT, 2014.
5. Francis daCosta, *“Rethinking the Internet of Things: A Scalable Approach to Connecting Everything”*, 1st Edition, Apress Publications, 2020.

25PR736

CONTROL SYSTEM DESIGN

3-0-0-3

Course Outcome

CO1	Design a controller/compensator using time and frequency domain techniques
CO2	Develop different structural configurations of PID controllers and the tuning methods
CO3	Design observers and controllers for linear systems in order to implement the methodology for practical control systems.
CO4	Develop and utilize modern software tools for analysis and design of linear continuous system.

Course Articulation Matrix: Correlation level [1: low, 2: medium, 3: High]

PO	PO1	PO2	PO3	PSO1	PSO2
CO					
CO1	3	1	3	3	2
CO2	3	1	2	2	1
CO3	3	1	3	3	1
CO4	3	1	3	3	3

Control system design by root locus method: lag, lead, lag-lead compensators, control system design by frequency response: lag, lead, lag-lead compensators. PID controller design: Tuning algorithms for PID controllers, optimal PID tuning, anti-reset wind up, derivative kick, modifications to conventional PID controller. Design of control system in state space: Pole placement controller, selection of pole locations for good design, control law design for full state feedback, design of servo systems. Observer design: Reduced order observer, design of regulator systems with observers. Computer-aided designs. Advanced Control system design technologies

Simulations and case studies of classical controller design.

TEXTBOOKS & REFERENCES

1. M. Gopal, “Modern Control System Theory”, New Age International, 4th edition, 2021.
2. Benjamin C. Kuo, “Digital Control Systems”, Oxford University Press, 2006.

3. G. F. Franklin, J. D. Powell, and A. E. Naeini, "Feedback Control of Dynamic Systems", Pearson, 8th Edition 2019.
4. Graham C. Goodwin, Stefan F. Graebe, and Mario E. Salgado, "Control System Design", PHI Learning, 2015.
5. Norman S. Nise, "Control Systems Engineering", John Wiley & Sons PTE Ltd, 8th Edition 2020.

25PR737

SYSTEM ENGINEERING AND INTEGRATION

3-0-0-3

Course Outcome

CO1	Identify and apply key concepts of systems engineering.
CO2	Analyze the engineering practices and methods and apply them to develop engineered systems.
CO3	Develop and analyze system requirements using methods for verification, validation, tests, and collaborative tools for product development.
CO4	Apply advanced systems engineering methodologies to deliver optimized, high-quality systems suit the organization's needs requirements.

Course Articulation Matrix: Correlation level [1: low, 2: medium, 3: High]

PO	PO1	PO2	PO3	PSO1	PSO2
CO					
CO1	3	1	3	3	2
CO2	3	1	2	2	1
CO3	3	1	3	3	1
CO4	3	1	3	3	3

Introduction to Systems Engineering – Key definitions, System Life Cycle and Product Development Life Cycle, ISO/IEC 15288, Phase-Gate Model, Concept Exploration, Verification and Validation, Requirements Engineering and Analysis Techniques, Traceability, collaborative tool usage in team environments.

System Planning and trade Studies, Modelling, Simulation, and Systems Analysis, MBSE using SysML, Specialty Engineering, risk management - concepts, tools and techniques, Introduction to Agile SE concepts in planning and risk iterations, early-phase and carry-over into later product development stages, Digital Thread and Digital Twin integration.

Systems Engineering Roles in Lifecycle Management, SE methodologies-concurrent engineering, design for six sigma and total quality development as they apply to the systems engineering roles, responsibilities, and the development of high-quality products in any market, industry, or sector

TEXTBOOK / REFERENCES:

1. Benjamin S. Blanchard and Wolter J. Fabrycky, "Systems Engineering and Analysis", 5th ed., Prentice Hall International Series in Industrial and Systems Engineering, (Upper Saddle River, NJ), 2006. ISBN-13: 978-0-13-221735-4.
2. Systems Engineering Principles and Practice, 3rd Edition (2020)
Authors: Alexander Kossiakoff, William Biemer, Samuel Seymour, David Flanigan
3. Kossiakoff, Alexander. Systems engineering principles and practice. John Wiley & Sons, 2011.

**25PR738 GENERATIVE AND REINFORCEMENT LEARNING FOR
SMART GRID AND EV SYSTEMS**

3-0-0-3

Course Outcome

CO1	Apply foundational and advanced Reinforcement Learning (RL) algorithms for modeling intelligent energy systems
CO2	Analyze and implement Generative AI models for synthetic data generation and intelligent forecasting in Smart Grid and Electric Vehicle (EV) applications.
CO3	Implement Generative Adversarial Network (GAN) architectures in energy systems
CO4	Demonstrate scalable data-driven pipelines for monitoring and decision-making in energy systems

Course Articulation Matrix: Correlation level [1: low, 2: medium, 3: High]

PO	PO1	PO2	PO3	PSO1	PSO2
CO					
CO1	2	1	3	3	1
CO2	2	1	3	2	
CO3	3	1	2	2	
CO4	1	1	1	2	

Reinforcement Learning (RL) in Energy Systems: RL basics: agent, environment, reward, policy, Tabular methods: Q-Learning, SARSA, Policy gradient methods, Deep Reinforcement Learning: DQN (Deep Q Network), DDPG (Deep Deterministic Policy Gradient), PPO (Proximal Policy Optimization) Generative AI for Smart Grids & EVs: Introduction to generative AI: concepts & significance Transformer models- BERT, GPT, Diffusion models and multimodal learning Generative Adversarial Networks: GAN architecture: generator vs discriminator, Loss functions and training challenges, Variants: Conditional GAN (CGAN), CycleGAN, TimeGAN Big Data Architectures for Energy, Data Ingestion and Storage Real-time data pipelines, Data Cleaning & Preprocessing Techniques. Analytics and Visualization Tools

TEXTBOOKS & REFERENCES:

1. *Ian Goodfellow, Yoshua Bengio, Aaron Courville, "Deep Learning", MIT Press, 2016*
2. *Richard S. Sutton & Andrew G. Barto, "Reinforcement Learning: An Introduction", 2nd Edition, MIT Press, 2018*
3. *AurélienGéron O'Reilly, "Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow", 3rd Edition, 2022*
4. *Research Papers*

**25PR741 ADVANCED OPTIMIZATION TECHNIQUES FOR POWER SYSTEM
APPLICATIONS**

3-0-0-3

Course Outcome

CO1	Illustrate various classical optimization techniques and the need for evolutionary optimization techniques
CO2	Analyze the concept of various nature inspired optimization techniques.
CO3	Formulate multi objective optimization problems using nature inspired algorithms.
CO4	Apply various evolutionary algorithms to optimize the operation of power systems

Course Articulation Matrix: Correlation level [1: low, 2: medium, 3: High]

PO	PO1	PO2	PO3	PSO1	PSO2
CO					
CO1	2	-	1	-	-
CO2	3	-	3	-	-
CO3	2	-	3	-	-
CO4	3	1	3	2	-

Prerequisite: Numerical computation and optimization

Definition-Classification of optimization problems-Unconstrained and Constrained optimization, Optimality conditions - Linear and non-linear programming, Quadratic programming, Intelligent Search methods - Evolutionary approaches.

Fundamentals of Evolutionary algorithms- Simulated annealing (SA) algorithm - Genetic Algorithm (GA) -Genetic Operators - Selection, Crossover and Mutation-Issues in GA implementation - GA based solution for Economic load Dispatch and unit commitment.

Particle Swarm Optimization (PSO) - principle - parameter selection - Issues in PSO implementation, Differential Evolution (DE) algorithm, applications to Economic Load Dispatch and Optimal power flow. Tabu search algorithm, Ant Colony Optimization (ACO) - applications to unit commitment.

Introduction to Hybrid optimization methods. Multi Objective Optimization - Concept of pareto optimality - Conventional approaches - Non-dominated sorting/ranking approaches for MOOP - applications to Economic Emission dispatch. Simulation case studies.

TEXTBOOKS & REFERENCES:

1. Kalyanmoy Deb, "Optimization for Engineering Design", Prentice Hall of India, 2nd edition, 2012.
2. D.P.Kothari and J.S.Dhillon, "Power System Optimization", 2nd Edition, PHI learning private limited, 2010.
3. Soliman Abdel Hady, Abdelaal Hassan Mantawy, "Modern optimization techniques with applications in Electric Power Systems", Springer, 2012.
4. Kalyanmoy Deb, "Multi objective optimization using Evolutionary Algorithms", John Wiley and Sons, 2008.
5. Carlos A.Coello, Gary B. Lamont, David A.Van Veldhuizen, "Evolutionary Algorithms for solving Multi Objective Problems", 2nd Edition, Springer, 2008.
6. KwangY.Lee, Mohammed A. El Sharkawi, "Modern heuristic optimization techniques", John Wiley and Sons, 1st edition, 2008.

25PR742

BIO-ENERGY CONVERSION

3-0-0-3

Course Outcome

CO1	Illustrate the basics and principles of bio energy conversion methods
CO2	Familiarize the concept of biomass usage for electricity generation
CO3	Evaluate the biogas production methods and storage
CO4	Analyze various types of algae and its usage for oil production and electricity generation

Course Articulation Matrix: Correlation level [1: low, 2: medium, 3: High]

PO	PO1	PO2	PO3	PSO1	PSO2
CO					
CO1	1	1	1		
CO2	2	1	3		
CO3	2	1	2		
CO4	2	1	3		

Bio energy: Renewability and sustainability of biomass, origin of biomass (Photosynthetic process) sources, Carbon Footprint and Emission Metrics of Biomass versus Fossil Fuels. Environmental Impact Assessment (EIA) in Bioenergy Projects characteristics, Energy farming, biofuel production process, biomass conversion methods, pyrolysis, gasification, types of biomass gasification, biogas systems and classifications. Bioenergy in Smart Grids and integration with demand-side management, Green hydrogen production from Biomass, Combined Heat and Power (CHP) from Biomass. Anaerobic digestion of wastes, high performance bio-gas systems, cleaning of biogas, use of bio- mass for electricity production, bio-gas compression, and storage. Upgrading biogas to bio-CNG, membrane separation, and biogas bottling techniques. Micro algae for oil production, Straight Vegetable Oil (SVO) in engines, Genetic Engineering of Algae for Enhanced Lipid Production. Algae in Wastewater Treatment and Simultaneous Biofuel Production, Algae-Derived Jet Fuels and Aviation Applications. Microbial Fuel Cell, configurations, organic wastes to electricity, Waste to Energy (WTE) systems for Municipal Solid Wastes (MSW), vegetable, fish and meat processing residues for biodiesel production, bio energy for stand- alone electrification, hybrid renewable energy systems. Simulation and case studies.

TEXTBOOKS & REFERENCES:

1. *Prabir Basu, "Biomass Gasification, Pyrolysis, and Torrefaction: Practical Design, Theory, and Climate Change Mitigation," Elsevier Inc., 2023.*
2. *Sunggyu Lee and Y. T. Shah, "Biofuels and Bioenergy: Processes and Technologies," CRC Press, Taylor & Francis Group, 2013.*
3. *Erik Dahlquist, "Biomass as Energy Source Resources, Systems and Applications," CRC Press, Taylor & Francis Group, UK, 2013.*
4. *G N Tiwari, M K Ghosal, "Fundamentals of Renewable Energy Sources," Narosa Publishing House, 2005.*

25PR743

ICT ENABLED POWER SYSTEM PROTECTION

3-0-0-3

Course Outcome

CO1	Illustrate the operation of different protection schemes.
CO2	Illustrate the numerical relay operations/functions
CO3	Apply signal processing techniques for protection scheme implementation
CO4	Apply and design technologies/ algorithms for real world protection applications

Course Articulation Matrix: Correlation level [1: low, 2: medium, 3: High]

PO					
CO	PO1	PO2	PO3	PSO1	PSO2
CO1	2	-	3	1	-
CO2	2	-	3	1	-
CO3	2	1	3	1	-
CO4	2	1	2	2	1

Role of ICT in Power System, IEEE Protection Standards & Guides, Protection Characteristics, Review of protection schemes. Numerical relay: principles, Data Acquisition Systems, RTU, IED, PMU, Wide Area Monitoring Systems (WAMS). Data Sampling and signal conditioning: FFT, DFT, Wavelet for protection algorithms. Fault location and identification, Protection in Distributed Generators (DGs), micro grids and smart grids, Protection coordination. ICT enabled protection schemes and modifications. Case study: Fault detection identification and classification, Adaptive protection coordination.

TEXTBOOKS/ REFERENCES:

1. *T.S.M. Rao "Digital/Numerical Relays" Tata McGraw-Hill Education, 01-Jul-2005.*
2. *Badari Ram and D. N. Viswakarma, "Power System Protection and Switchgear," Tata McGraw*

Hill, 3rd Edition, 2022.

3. Bhuvanesh A Oza, Nirmal-Kumar Nair, Rashesh Mehta, and Vijay Makwana , “Power System Protection and Switchgear”, McGraw Hill Education, 1st edition, 2017.
4. Y.G. Paithankar and S.R Bhide, “Fundamentals of Power System Protection,” Prentice-Hall of India, 2nd edition, 2013.
5. IEEE standards, Transaction papers on power system protection.

25PR744 MATHEMATICAL MODELLING OF ENERGY SYSTEMS

3-0-0-3

Course Outcome

CO1	Illustrate the need for mathematical models and various model examples.
CO2	Apply various techniques for power flow modelling.
CO3	Illustrate modelling methods for renewable energy systems, HVDC and STATCOM.
CO4	Analyze the effect of uncertainty and to develop various energy probabilistic models.
CO5	Develop solutions for differential modelling methods in standard test systems.

Course Articulation Matrix: Correlation level [1: low, 2: medium, 3: High]

PO					
CO	PO1	PO2	PO3	PSO1	PSO2
CO1	1	-	1	-	-
CO2	2	-	2	-	-
CO3	2	-	2	-	-
CO4	2	-	2	-	-
CO5	2	-	-	-	-

Energy system modelling: background, motivations, modelling physical systems, time scales of power system dynamics, energy system architecture, energy system scripting, Synchronous machine modelling. Analysis of energy systems: power flow analysis, modelling and solution by Newton Raphson method, continuation power flow analysis, modelling, and solution by homotopy methods, optimal power flow analysis, modelling, and solution by gradient method. Modelling of Renewable Energy: operation of PV & Wind energy systems, frequency impact& voltage analysis, modelling of solid oxide fuel cell and battery energy storage. Modelling of HVDC transmission system and voltage source converter, modelling of STATCOM and analysis. Dealing with uncertainty and probabilistic techniques: uncertainty power flow analysis and probabilistic optimal power flow analysis. Case studies of various analyses on standard IEEE test system.

TEXTBOOKS/ REFERENCES:

1. Federico Milano, “Power System Modelling and Scripting”, Springer Science & Business Media, 2010.
2. L.P. Singh, “Advanced Power System Analysis and Dynamics”, New Age International, 2012.
3. Subhes C. Bhattacharyya, “Energy Economics: Concepts, Issues, Markets and Governance”, Springer Science & Business Media, 2019.
4. Jizhong Zhu, “Optimization of Power System Operation”, IEEE Press Series on Power Engineering, John Wiley & Sons, 2016.
5. S. S. Rao, “Engineering Optimization: Theory and Practice”, John Wiley and Sons, 2019.

Course Outcome

CO1	Analyse the current global energy scenario and evaluate the significance, availability, and measurement of solar radiation for renewable energy applications.
CO2	Compare various solar photovoltaic (PV) technologies, including their manufacturing processes, materials, and performance modeling techniques.
CO3	Evaluate standalone, grid-connected, and hybrid solar PV systems along with component selection and cost-benefit analysis for practical implementation.
CO4	Examine and apply maximum power point tracking (MPPT) techniques, solar tracking mechanisms, and solar forecasting methods in PV systems for enhanced efficiency.
CO5	Design solar thermal systems and compute energy outputs for various thermal applications using appropriate methods and tools.

Course Articulation Matrix: Correlation level [1: low, 2: medium, 3: High]

PO	PO1	PO2	PO3	PSO1	PSO2
CO					
CO1	-	-	1		-
CO2	1	-	1	1	-
CO3	2	-	2	1	-
CO4	3	-	3	2	1
CO5	1	-	1	-	-

Review of solar energy systems. Solar photovoltaic applications: types of systems, system design, balance of solar PV systems, Solar PV inverter & converter design, controllers, energy storage options for solar PV systems, battery & fuel cell, site selection for SPV systems, design of off-grid, grid connected & hybrid PV systems, IEEE standards for grid integration, installation & maintenance of SPV plants, life cycle cost analysis.

Application-specific considerations and system integration using AI - ML –in solar street lighting, heating, drying, PV array etc: Design considerations & system design. Solar energy collectors, concentrators, and heliostat systems. Solar thermal system: space/ air heating & cooling, active & passive heating and cooling of buildings, solar dryers for process plants, solar pond, solar collector, solar thermal power plant and thermal storage: steady state and dynamic analysis, modelling of solar thermal systems and simulation tools and case studies for PV and thermal system analysis, floating solar farms. ICT tools in solar energy monitoring and control.

Design of active systems by f-chart and utilization methods. Thermoelectric-photovoltaic integrated modules for heating and electricity applications, solar hydrogen generation. Applications: Solar vehicle, Telecommunication, Naval and Space, ICT applications in solar energy sector. Simulation and case studies.

TEXTBOOKS/ REFERENCES:

1. Chetan Singh Solanki, “Solar Photovoltaics: Fundamentals, Technologies and Applications”, Second Edition, Prentice Hall of India, Third Edition, 2018.
2. S. P. Sukhatme, “Solar Energy - Principles of Thermal Collection and Storage”, Third Edition, Tata McGraw-Hill, New Delhi, 4th edition 2023
3. D. Y. Goswami, F. Kreith and J. F. Kreider, “Principles of Solar Engineering”, fourth edition, Taylor and Francis, Philadelphia, 2022.
4. Jeffrey R.S. Brownson “Solar Energy Conversion System” Academic press, Elsevier Inc. 2014.
5. Alireza Khaligh, Omer C. Onar “Energy Harvesting: Solar, Wind, and Ocean Energy Conversion Systems” Taylor and Francis CRC press, 2010

Course Outcome

CO1	Evaluate the fundamentals of wind energy conversion, including aerodynamic principles, turbine technologies, and methodologies for wind resource assessment.
CO2	Analyse the structural and electrical design of wind turbines, including load estimation, component selection, and energy storage integration for performance optimization.
CO3	Assess strategies for integrating wind power into modern electrical grids, addressing challenges in intermittency, control systems, and grid code compliance.
CO4	Investigate emerging smart technologies in wind energy systems, such as digital twins, machine learning-based forecasting, and intelligent monitoring systems.
CO5	Perform techno-economic analysis of wind energy projects, including capital and operational cost estimation, levelized cost of energy (LCOE), and payback period modelling.

Course Articulation Matrix: Correlation level [1: low, 2: medium, 3: High]

PO	PO1	PO2	PO3	PSO1	PSO2
CO					
CO1	3	2	3	1	1
CO2	3	2	3	2	1
CO3	3	2	3	2	1
CO4	2	2	3	1	1
CO5	3	2	3	1	1

History and Evolution of Wind Turbine Technology, Global and Indian Wind Energy Scenario, Emerging Trends in Wind Energy, Principles of Wind Energy Conversion, Wind Turbine Aerodynamics, Wind Resource Assessment Techniques, Wind Regime Modelling, Weibull Distribution and Statistical Parameters, Height Dependency and Terrain Considerations, Wind Measurement Instruments (Anemometers, LIDAR, SODAR), Wind Forecasting Methods (Short-term and Long-term), Betz Limit and Energy Extraction Theory, Blade Element Theory, Rotor Design Principles.

Classification of Wind Turbines (Horizontal vs. Vertical Axis, Two-blade vs. Three-blade) Rotor Design Aspects (Blade Profile, Number of Blades, Coning, Teetering), Power Regulation Methods (Stall, Pitch, Active Yaw Control), Turbine Loads (Aerodynamic Effects, Tower Shadow, Turbulence), Mechanical and Structural Components (Braking Systems, Yaw Systems, Towers), Wind Turbine Generator Systems (WTGS), Fixed-Speed and Variable-Speed Configurations, Synchronous and Asynchronous Generators, Power Electronics (Converters, Inverters), Control Units and Control System Architecture, Sensors, Actuators, and Control Algorithms, Wind Energy Storage Technologies, Grid Integration Methods (Direct and Converter-based), Grid Code Compliance and Reactive Power Control, Offshore Wind Turbines – Design and Environmental Considerations.

Site Assessment and Selection Criteria, Turbine Spacing and Optimal Placement, Rotor Diameter and Hub Height Considerations, Estimation of Annual Energy Output (AEO), SCADA and ICT-Based Monitoring Systems, Noise and Environmental Impact, Small Wind Turbines – Design, Certification, Deployment, Economic Evaluation of Wind Projects, Capital and Operational Cost Components, Payback Time and Financial Modelling, Levelized Cost of Energy (LCOE), Case Studies and Simulation-Based Design Tools.

TEXTBOOKS/ REFERENCES:

1. Joshua Earnest and Tore Wizelius, "Wind Power Plants and Project Development", PHI Learning Pvt. Ltd., New Delhi, 2nd Edition, 2015.
2. J. F. Manwell, J. G. McGowan, and A. L. Rogers, "Wind Energy Explained - Theory, Design and Application", Wiley, 2009.
3. Earnest Joshua, "Wind Power Technology", Second edition, PHI Learning Pvt. Ltd., New Delhi, 3rd edition, 2019.
4. Johnson G. L., "Wind Energy Systems", Prentice Hall, 2001 (published by the author online).
5. Spera D. A., "Wind Turbine Technology: Fundamental Concepts of Wind Turbine

- Engineering”, ASME Press, New York, 2nd edition, 2009.*
6. Voker Quashning, "Understanding Renewable Energy Systems", Earthscan, Second edition, 2nd edition, 2016.
 7. Tony Burton, David Sharpe, Nick Jenkins, Ervin Bossanyi, "Wind Energy Handbook" John Wiley & sons, ltd, 3rd Edition, 2021.

25PR747

ENERGY CONSERVATION AND MANAGEMENT

3-0-0-3

Course Outcome:

CO1	Develop proficiency in energy management and conservation, emphasizing strategic planning and policy formulation
CO2	Conduct basic energy audits and recommend feasible conservation measures using appropriate instruments
CO3	Analyze methods for thermal energy conservation and techniques for enhancing energy efficiency.
CO4	Design efficient electrical load and lighting management systems to enhance energy efficiency.
CO5	Impart computer aided tools for energy management, energy efficiency policy initiatives, energy economic analysis and tools used.

Course Articulation Matrix: Correlation level [1: low, 2: medium, 3: High]

PO	PO1	PO2	PO3	PSO1	PSO2
CO					
CO1	2	2	1	1	1
CO2	3	2	2	1	1
CO3	2	2	2	1	1
CO4	3	2	2	2	2
CO5	2	2	2	1	1

Energy Conservation and Management: general principles of energy management and planning, energy audit and opportunities for energy conservation (OEC),. Electricity Regulation and Policies.

Energy efficiency analysis, management of heating, Heat Ventilating and Air- Conditioning (HVAC), management of process energy, Energy efficiency of turbines, compressors and pumps, specific energy consumption, parameters affecting specific energy consumption, flexi targeting technique. Cogeneration: types and schemes.

Management opportunities of electrical load-, lighting and electric drives, Energy Efficiency in motors, pumps and fans, lighting, electrical load analysis, Demand side Management and Demand Response. Economics of power factor improvement: reactive power management, capacitor sizing, location, placement, maintenance, - Computer -aided energy management, energy efficiency- policy initiatives.

Energy Economics: Time value of money - Present Worth and Future Worth Economic performance indices: Financial evaluation of energy projects, evaluation of proposals, profitability index, life cycle costing approach, investment decision and uncertainty. Energy conservation in vehicles, energy conservation in buildings - Net Zero Energy Building, Power quality issues related to Energy Efficient Technologies, Energy Conservation Practice

Projects / case studies in (energy audit, Energy efficiency analysis, Computer -aided energy management, Energy conservation)

TEXTBOOKS/ REFERENCES:

1. Barney L. Capehart, Wayne C. Turner and William J. Kennedy, "Guide to Energy Management", Seventh Edition, The Fairmont Press Inc., 2015.
2. Albert Thumann, "Handbook of Energy Audits", Sixth Edition, The Fairmount Press, 2012

3. G. G. Rajan, "Optimizing Energy Efficiencies in Industry", Tata McGraw Hill, 2003.
4. Wayne C. Turner, "Energy Management Handbook", The Fairmount Press, Inc., 2012.
5. Charles M. Gottschalk, "Industrial Energy Conservation", John Wiley and Sons, 1996.
6. Craig B. Smith, "Energy Management Principles", Pergamon Press, 2015
7. <https://beeindia.gov.in/>

25PR751 ELECTRIC VEHICLE CHARGING INFRASTRUCTURE 3-0-0-3

Course Outcome:

CO1	Analyse the various charging infrastructures
CO2	Analyse the impact of EV charging on grid
CO3	Evaluate the various charging methodologies and analyse their performances
CO4	Design the and analyse the renewable energy based electric vehicle charging station

Course Articulation Matrix: Correlation level [1: low, 2: medium, 3: High]

PO	PO1	PO2	PO3	PSO1	PSO2
CO					
CO1	2	2	3	3	1
CO2	3	2	3	3	1
CO3	3	2	3	3	1
CO4	3	3	3	3	2

Introduction, EV charging options and infrastructure, energy, economic and environmental considerations, Impact of EV charging on power grid-distribution system, effect of EV charging on generation and load profile, Smart charging technologies, Identification of EV demand, General safety requirement for electric vehicle charging stations: IS/IEC 62305.

Types of charging stations and Charging Infrastructure, Battery Swapping Station, Move-and-charge zone. AC charging and DC charging - On board and off board charger specification - EVSE technical specification and charging time calculation - Selection and sizing of fast and slow charger (AC & DC). Charging – Interoperability of chargers, impact of battery life due to chargers

Renewable Energy based Electric Vehicle Charging Station - Calculation and Selection - Components of Charging Station - Earth protection system for charging stations – Fire & safety aspects of charging stations, EV impacts on system demand: dumb charging, multiple tariff charging, smart charging, burp charging, negative pulse charging, random charging, high speed/fast charging

Case studies on recent advancements in EV charging

TEXTBOOKS/ REFERENCES:

1. A. Khajepour, S. Fallah and A. Goodarzi, "Electric and Hybrid Vehicles Technologies, Modeling and Control: A Mechatronic Approach", John Wiley & Sons Ltd, 2014.
2. Emadi, A. (Ed.), Miller, J., Ehsani, M., "Vehicular Electric Power Systems" Boca Raton, CRC Press, 2003
3. M. Ehsani, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2013.
4. C. C. Chan and K. T. Chau, Modern Electric Vehicle Technology, Oxford Science Publication, 2001
5. Datta, Prabir, and Gianfranco Pistoia, Electric and Hybrid Vehicles Power Sources, Models, Sustainability, Infrastructure and the Market, 2010
6. M. H. Rashid, Power Electronics: Circuits, Devices and Applications, 4th ed., Pearson, 2004 8. V. R. Moorthi, Power Electronics: Devices, Circuits and Industrial Applications, Oxford University Press, 2023

25PR752

HYBRID AND ELECTRIC VEHICLES

3-0-0-3

Course Outcome:

CO1	Develop and apply basic mathematical models to simulate and predict vehicle performance
CO2	Analyse performance characteristic and model dynamics of hybrid and electric vehicles
CO3	Analyse the architecture of drive trains and electric propulsion units of electric and hybrid vehicles

Course Articulation Matrix: Correlation level [1: low, 2: medium, 3: High]

PO	PO1	PO2	PO3	PSO1	PSO2
CO					
CO1	3	2	3	3	1
CO2	3	1	3	3	1
CO3	2	2	3	3	2

Conventional Vehicles: Basics of vehicle performance, vehicle power source characterization, transmission characteristics, mathematical models to describe vehicle performance

Introduction to Hybrid Electric Vehicles: History of hybrid and electric vehicles, types of hybrid EV, Dynamics of hybrid and electric vehicles- motion and dynamic equations for vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies,

Hybrid and Electric Drive-trains: Basic concept of traction, introduction to various drive-train topologies, power flow control in 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.

TEXTBOOKS/ REFERENCES:

1. I. Husain, *Electric and Hybrid Electric Vehicles, Third Edition*, CRC Press, 2021
2. M. Ehsani, *Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design*, CRC Press, 2013.
3. C. C. Chan and K. T. Chau, *Modern Electric Vehicle Technology*, Oxford Science Publication, 2001
4. Datta, Prabir, and Gianfranco Pistoia, *Electric and Hybrid Vehicles Power Sources, Models, Sustainability, Infrastructure and the Market*, 2010
5. M. H. Rashid, *Power Electronics: Circuits, Devices and Applications*, 4th ed., Pearson, 2004 8. V. R. Moorthi, *Power Electronics: Devices, Circuits and Industrial Applications*, Oxford University Press, 2023.

25PR753

AUTOMOTIVE EMBEDDED SYSTEMS AND CONTROL

3-0-0-3

Course Outcome:

CO1	Gain insights into the embedded system design concepts tailored to automotive applications.
CO2	Analyze performance and safety of embedded systems in automotive applications.
CO3	Design embedded systems for automotive applications.

Course Articulation Matrix: Correlation level [1: low, 2: medium, 3: High]

PO	PO1	PO2	PO3	PSO1	PSO2
CO					
CO1	2	1	1	1	-
CO2	2	1	2	1	-
CO3	3	1	2	3	-

Pre-requisites: Knowledge on Microcontrollers, Embedded systems, and EV technology.

Overview of automotive ECUs and domain controllers. Basics of automotive control systems. Automotive Microcontrollers: Features of automotive-grade microcontrollers (TI C2000, Infineon Aurix, NXP S32K, STM32); Architecture, memory organization, timers, ADC, PWM, and communication protocols. Real-time operating systems (RTOS): FreeRTOS, AUTOSAR OS, Task scheduling, inter-task communication, synchronization. Introduction to Vehicle Diagnostics: Regulatory and industry standards, On board diagnostics (OBD), diagnostic trouble code (DTC) retrieval, remote fault detection. Model-Based Development and Software Tools: State flow for control logic. Embedded C code generation. HIL (Hardware-in-the-loop) and SIL (Software-in-the-loop) testing.

TEXTBOOKS:

1. William B. Ribbens, "Understanding Automotive Electronics", Eighth edition, 2020.
2. Francoise Simonot-Lion (Editor), Nicolas Navet (Editor), "Automotive Embedded Systems Handbook (Industrial Information Technology)", CRC Press, 2008.
3. Joseph Yiu, "The Definitive Guide to ARM® Cortex®-M3 and Cortex®-M4 Processors", Third edition, 2013.
4. Qing Li, Caroline Yao, "Real-Time Concepts for Embedded Systems", 2010.
5. Gabriela Nicolescu, Pieter J. Mosterman, "Model-based design for embedded systems", 2009.

REFERENCES:

1. STM32 Reference manual, ST Electronics, 2021.
2. TMS320F2837xD Dual-Core Real-Time Microcontrollers Technical Reference manual, Texas Instruments, 2024.
3. MSP430F2xx, MSP430G2xx Family User's Guide, Texas Instruments, 2022.

25PR754**VEHICLE DYNAMICS AND CONTROL****3-0-0-3****Course Outcome**

CO1	Develop ability to choose suitable Driver Assistance Systems
CO2	Analyze the different models of lateral and longitudinal vehicle dynamics
CO3	Design different models and control methods to improve the stability of vehicular systems.
CO4	Develop the ability to design vehicle dynamics control systems using electronics.

Course Articulation Matrix: Correlation level [1: low, 2: medium, 3: High]

PO	PO1	PO2	PO3	PSO1	PSO2
CO					
CO1	1	-	1	-	-
CO2	2	-	3	1	-
CO3	2	-	3	1	-
CO4	3	-	3	1	-

Introduction to driver assistance systems-levels, active stability control, ride quality, technologies for addressing traffic congestion, emissions and fuel economy;

Lateral Vehicle Dynamics: Types of lateral systems, kinematic models, dynamic bicycle model, from body fixed to global coordinates: lateral vehicle control: Steering control for automated lane keeping - state feedback, steady state analysis: understanding steady state cornering, the output feedback problem-compensator design with look ahead measurement,

Longitudinal Vehicle Dynamics: longitudinal vehicle model, driveline dynamics, longitudinal vehicle control: cruise control, architecture, adaptive cruise control, Anti-lock brake systems (ABS).

Individual vehicle stability and string stability- string stability with constant spacing, string stability with constant time gap, controller for transitional maneuvers, automated highway systems, longitudinal control for vehicle platoons, string stability with inter-vehicle communication

Electronics Stability Control: control design for differential braking based systems, a steer-by-wire system, All-wheel-drive(AWD) torque control: active automotive suspensions: H2 optimal control, LQR formulation for active suspension design, semi-active automotive suspensions:optimal semi-active suspensions.

Rollover Prevention Control: rollover dynamics, rollover index and active rollover prevention, comparison of performance with various rollover indices.

Lab Experiments Based on Simulation Tools.

TEXTBOOKS/REFERENCES:

1. Thomas D. Gillespie, "Fundamentals of Vehicle Dynamics", SAE International, 2021.
2. R. Rajamani, "Vehicle Dynamics and Control", Second Edition, Springer Verlag, 2012.
3. Azadi, Shahram; Kazemi, Reza; Nedamani, Hamidreza Rezaei, "Vehicle Dynamics and Control: Advanced Methodologies", Elsevier, 2021
4. Uwe Kiencke and Lars Nielsen, "Automotive Control Systems: For Engine Driveline, and Vehicle", Second edition, Springer, 2005.
5. Hans B. Pacejka, "Tyre and Vehicle Dynamics", Third Edition, Butterworth-Heinemann, 2012

25PR755

AUTOMOTIVE ELECTRONICS

3-0-0-3

Course Outcome

CO1	Analyze various vehicle electronic circuits and their roles in body, powertrain, and chassis subsystems.
CO2	Assess the functional principles and applications of automotive sensors and Electronic Control Units (ECUs).
CO3	Evaluate the importance of safety systems in enhancing automotive reliability and occupant protection.
CO4	Evaluate the working of batteries, starting systems, charging systems, ignition systems and auxiliaries. Assess the operation and diagnostics of batteries, starting systems, charging systems, ignition systems, and auxiliary electrical components.

Course Articulation Matrix: Correlation level [1: low, 2: medium, 3: High]

PO					
CO	PO1	PO2	PO3	PSO1	PSO2
CO1	3	-	-	-	-
CO2	3	3	3	2	-
CO3	3	3	3	2	1
CO4	3	3	3	1	-

Introduction to electronic systems in Automotives – Overview of sensors and actuators used in body, powertrain, and chassis systems. Body electronics domain – Automotive alarms, lighting, central locking and electric windows, climate control, driver information systems, and parking assistance. Powertrain and chassis control systems – Engine management, transmission control, ABS, ESP, traction control, active suspension, safety systems, and adaptive cruise control. Advanced Driver Assistance Systems (ADAS). System integration and control – Hardware implementation examples of simple automotive subsystems using sensors, controllers, and actuators; Electronics for vehicular energy systems-Batteries, alternators and starting motor systems. Vehicle communication and diagnostics – Vehicle networks and communication buses, and On-Board Diagnostics (OBD).

TEXT BOOKS/REFERENCES:

1. Bosch, “Automotive Electrics and Automotive Electronics. System and components ,Networking and Hybrid drive”, Fifth edition, Springer Vieweg 2014
2. Najamuz Zaman , “ Automotive Electronics Design Fundamental” first edition, Springer 2015.
3. Hillier’s, “Fundamentals of Motor Vehicle Technology on Chassis and Body Electronics”, Fifth Edition, Nelson Thrones, 2007.
4. William B. Ribbens, “Understanding Automotive Electronics” Sixth Edition, Elsevier Newnes, 2002

25PR756

E-MOBILITY BUSINESS AND POLICIES

3-0-0-3

Course Outcome

CO1	Develop ability to analyze the need for urban mobility and efficient public transportation in India
CO2	Illustrate various electric mobility and shared mobility services and its business
CO3	Analyze the incentives to promote electric mobility and sharing
CO4	Evaluate the basics and deployment standards of EV charging stations and renewable energy integration to charging station

Course Articulation Matrix: Correlation level [1: low, 2: medium, 3: High]

PO	PO1	PO2	PO3	PSO1	PSO2
CO					
CO1	1	-	1	-	-
CO2	2	-	2	-	-
CO3	1	-	1	-	-
CO4	3	-	2	-	-

Introduction to E-Mobility: Evolution of transportation and emergence of electric mobility, Environmental and economic benefits of e-mobility,

EV Technologies and Infrastructure: Infrastructure planning and deployment challenges, Electrification of public and freight transport, Emerging trends: autonomous EVs, shared mobility, hydrogen mobility,

Business Models and Market Dynamics: EV ecosystem and stakeholder analysis, Business models: (Business-to-Consumer) B2C, (Business-to-Business) B2B, business models for charging station operators (CPOs), e-mobility service providers (EMSPs), fleet charging, and home charging, leasing, subscription, battery-as-a-service, Cost analysis, Investment trends, start-ups, and market players,

Policies and Regulatory Framework: Communication standards-communication architecture for DC fast charging, communication protocols and verification procedures that support electric vehicle (EV)-grid connectivity, criteria for connecting EV to utility for AC level 1 and level 2 charging. Nature and scope of policies to stimulate widespread EV adoption and support EVCI station implementation; policy formulation and implementation at various levels of government; examples of policies and

incentives for EV adoption Global EV policy landscape: Subsidies, carbon credits, and taxation, Standards and regulations (AIS, IEC, ISO)

TEXTBOOK/REFERENCES:

1. *Electric Vehicle Technology Explained* – James Larminie and John Lowry, John Wiley & Sons (Wiley), 2nd Edition, 2012
2. *The Electric Vehicle and the Burden of History* – David A. Kirsch, Rutgers University Press, 2000.
3. *NITI Aayog and Rocky Mountain Institute Reports on E-Mobility*
4. *International Energy Agency (IEA) Global EV Outlook Reports*
5. *Government of India EV Policies (FAME, NEMMP)*

25PR757 **INDUSTRY TRENDS IN AUTOMOTIVE ELECTRIFICATION – VALEO GERMANY** **3-0-0-3**

Course Outcomes:

CO1	Analyze the evolution of traction inverters and the transition from 400V to 800V platforms.
CO2	Analyze the design principles and advantages of PMSMs and emerging motor technologies
CO3	Illustrate the architecture, benefits, and integration challenges of E-axles.
CO4	Apply HV safety standards in automotive EV systems
CO5	Identify EMC challenges and mitigation techniques in EV powertrains.

Course Articulation Matrix: Correlation level [1: low, 2: medium, 3: High]

PO	PO1	PO2	PO3	PSO1	PSO2
CO					
CO1	3	–	3	2	1
CO2	3	–	3	2	1
CO3	2	–	3	3	1
CO4	3	1	3	3	1
CO5	3	1	3	3	1

Syllabus from Valeo Germany:

Automotive Electrification Trends: Overview of EV adoption trends: Global and Indian context, Transition from 400V to 800V systems: motivation, benefits, and challenges, Si vs SiC inverter technologies: switching frequency, efficiency, thermal performance, Thermal management in high-voltage systems.

Traction Inverters and Power Electronics: Traction inverter topologies and design considerations, Switching devices and gate driver techniques, Current sensor types and control for automotive-grade inverters, ISO 26262 implications in inverter design, Regenerative braking and bidirectional power flow.

Motor Technologies: Permanent Magnet Synchronous Motors (PMSM): design, control, and performance, IPMSM vs SPMSM vs SRM: comparison and selection criteria, High-speed motor trends and cooling strategies, Advanced winding technologies (hairpin, concentrated windings, etc.), Innovations in magnet materials and rotor designs

E-Axle Systems and Integration: Introduction to E-Axle architecture, Integration of motor, inverter, and gearbox, Power density and packaging constraints, System-level NVH considerations, Thermal interfaces and compact integration

High Voltage (HV) Safety in EVs: Functional safety principles (ISO 26262 overview), HV interlock loop, insulation monitoring, and fault diagnosis, Contactors, relays, and safety controller interface, Battery disconnection and emergency shutdown.

Electromagnetic Compatibility (EMC): EMC challenges in automotive inverters and motors, Sources of conducted and radiated EMI, Filtering, shielding, and PCB layout best practices, EMC testing procedures (CISPR 25), Case studies on EMC failures in EVs

TEXTBOOKS / REFERENCES:

1. *Iqbal Husain, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, Third Edition 2021*
2. *James Larminie, Electric Vehicle Technology Explained, Wiley, Second Edition, 2012*
3. *Industry whitepapers by Valeo, Infineon, Wolfspeed, and Tesla.*
4. *ISO 26262 documentation and standards for HV safety and EMC.*
5. *IEEE Transactions on Vehicular Technology and Industrial Electronics*

25AVP501

MASTERY OVER MIND

1-0-2-2

PG SYLLABUS

COURSE OBJECTIVES

Master Over the Mind (MAOM) is an Amrita initiative to implement schemes and organize university-wide programs to enhance health and wellbeing of all faculty, staff, and students (UN SDG -3). This program as part of our efforts for sustainable stress reduction introduces immediate and long-term benefits and equips every attendee to manage stressful emotions and anxiety facilitating inner peace and harmony. With a meditation technique offered by Amrita Chancellor and world-renowned humanitarian and spiritual leader, Sri Mata Amritanandamayi Devi (Amma), this course has been planned to be offered to all students of all campuses of AMRITA, starting off with all first years, wherein one hour per week is completely dedicated for guided practical meditation session and one hour on the theory aspects of MAOM. The theory section comprises lecture hours within a structured syllabus and will include invited guest lecture series from eminent personalities from diverse fields of excellence. This course will enhance the understanding of experiential learning based on university's mission: "Education for Life along with Education for Living" and is aimed to allow learners to realize and rediscover the infinite potential of one's true Being and the fulfilment of life's goals.

COURSE OUTCOME

After successful completion of the course, students will be able to:	
S.No.	Course Outcomes
1.	Understand the scientific benefits of meditation. (CO1)
2.	Explain the science behind meditation and its effects on physical and mental well-being (CO2).
3.	Understand the meditation techniques to cultivate emotional intelligence and improve relationships (CO3).
4.	Learn and practice MAOM meditation in daily life (CO4).
5.	To apply the effect of meditation to compassion-driven action (CO5)

Syllabus:

Scientific benefits of Meditation (CO1)

Scientific benefits of meditation, exploring its effects on physical and mental wellbeing.

Learn about the different types of meditation practices, the essential elements of meditation, and the empirical evidence supporting its benefits.

Video resource-Swami Atmanandamrita Puri

Science Behind Meditation (CO2)

A: A preliminary understanding of the Science of meditation. What can modern science tell us about this tradition-based method?

B: How meditation helps humanity according to what we know from scientific research

Reading 1: Does Meditation Aid Brain and Mental Health (Dr Shyam Diwakar)

Reading 2: 'Science and Spirituality.' Chapter 85 in Amritam Gamaya (2022). Mata

Amritanandamayi Mission Trust.

Role of Meditation in Emotional intelligence (CO3)

Learn how meditation practices can enhance self-awareness, self-regulation, motivation, empathy, and social skills, leading to improved relationships and decision-making. Improve communication, emotional intelligence, and interpersonal skills. Logical and analytical reasoning

Practicing MA OM Meditation in Daily Life (CO4)

Guided Meditation Sessions following scripts provided (Level One to Level Five)

Reading 1: MA OM and White Flower Meditation: A Brief Note (Swami Atmananda Puri)

Reading 2: 'Live in the Present Moment.' Chapter 71 in Amritam Gamaya (2022). Mata

Amritanandamayi Mission Trust.

Meditation and Compassion-driven Action (CO5)

Understand how meditation can help to motivate compassion-driven action.

Reading 1: Schindler, S., & Friese, M. (2022). The relation of mindfulness and prosocial behavior: What do we (not) know? Current Opinion in Psychology, 44, 151-156.

Reading 2: 'Sympathy and Compassion.' Chapter 100 in Amritam Gamaya (2022). Mata Amritanandamayi Mission Trust.

Textbooks / References:

1. Mata Amritanandamayi Devi, "Cultivating Strength and vitality," published by Mata Amritanandamayi Math, Dec 2019
2. Swami Amritaswarupananda Puri, "The Color of Rainbow" published by MAM, Amritapuri.
3. Craig Groeschel, "Winning the War in Your Mind: Change Your Thinking, Change Your Life" Zondervan Publishers, February 2019
4. R Nagarathna et al, "New Perspectives in Stress Management" Swami Vivekananda Yoga Prakashana publications, Jan 1986
5. Swami Amritaswarupananda Puri "Awaken Children Vol 1, 5 and 7 - Dialogues with Amma on Meditation", August 2019
6. Swami Amritaswarupananda Puri "From Amma's Heart - Amma's answer to questions raised during world tours" March 2018
7. Secret of Inner Peace- Swami Ramakrishnananda Puri, Amrita Books, Jan 2018.
8. Mata Amritanandamayi Devi "Compassion: The only way to Peace: Paris Speech", MA Center, April 2016.
9. Mata Amritanandamayi Devi "Understanding and collaboration between Religions", MA Center, April 2016.
10. Mata Amritanandamayi Devi "Awakening of Universal Motherhood: Geneva Speech" M A center, April 2016.

GLIMPSES OF INDIAN CULTURE		
P/F		
22ADM501: GLIMPSES OF INDIAN CULTURE		
A. Prerequisite: nil		
B. Nature of Course: Theory		
C. Course Objectives:		
- The course "Glimpses of Indian Culture" aims to provide students with a comprehensive understanding of various aspects of Indian culture, with a focus on its spiritual, philosophical, and religious dimensions. - Through an exploration of the chapters from the provided book, students will gain insights into the foundational principles, practices, and symbols that shape the diverse cultural landscape of India - Aligned with the Indian Knowledge Systems (IKS) framework outlined in the National Education Policy, this course serves as an introduction to the vast reservoir of wisdom and knowledge rooted in Indian heritage. - By engaging with the chapters in the book, students will develop a holistic appreciation for the rich tapestry of Indian culture, spanning from its philosophical underpinnings to its artistic expressions, rituals, and societal values. - This course aims to cultivate cultural sensitivity, critical thinking, and a deeper understanding of the diverse spiritual and cultural traditions that have shaped India's identity over millennia.		
D. Course Outcomes: After successful completion of the course, Students will be able to:		
CO	Course Outcomes	Knowledge level [Bloom's Taxonomy]
CO01	Recall key concepts and terms associated with Sanatana Dharma, scriptures, and core cultural elements of India. Statement: Demonstrate the ability to remember essential terms, concepts, and principles discussed in the chapters on Sanatana Dharma, scriptures, and cultural aspects.	Remembering
CO02	Explain the concepts of Īśvara, Guru Tattva, Avatara Tattva, and the Theory of Karma as foundational elements of Indian cultural philosophy. Statement: Understand the profound meanings of Īśvara, Guru, Avatara, and Karma, elucidating their importance in shaping Indian cultural thought.	Understanding
CO03	Apply the knowledge of Purusharthas, Sanyasa, and Yajna to analyze real-life ethical and spiritual scenarios. Statement: Utilize insights from Purusharthas, Sanyasa, and Yajna to navigate ethical dilemmas and make informed decisions.	Applying
CO04	Analyze the symbolism in cultural practices, Nataraja iconography, and temple architecture. Statement: Deconstruct the layers of symbolism in various cultural aspects, including Nataraja representation and temple architecture, unraveling their deep meanings.	Analyzing
CO05	Evaluate the significance of temples as cradles of culture and explore alternative systems in India's cultural landscape. Statement: Assess the role of temples in preserving cultural heritage and critically examine the diversity of cultural and spiritual systems in India.	Evaluating
CO06	Develop projects or presentations that highlight the essence of Sanatana Dharma, sadhana, and the cultural significance of symbols.	Creating

	Statement: Create expressive projects that capture the essence of Sanatana Dharma, convey the practices of sadhana, and portray the cultural meanings of symbols.	
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POs <u>Programme Outcomes</u>	COs
PO1: Engineering Knowledge PO2: Problem Analysis PO3: Design/Development of Solutions PO4: Conduct Investigations of complex problems PO5: Modern tools usage PO6: Engineer and Society PO7: Environment and Sustainability PO8: Ethics PO9: Individual & Teamwork PO10: Communication PO11: Project management & Finance PO12: Lifelong learning <u>B.Tech. EEE Programme Specific Outcome (PSO)</u> PSO1: Awareness of Future Technology: Develop solutions for future systems using smart technologies. PSO2: Research and Innovation: Identify engineering challenges, approach using cutting edge research tools and execute innovative solutions.	- CO 1: Recall key concepts and terms associated with Sanatana Dharma, scriptures, and core cultural elements of India. - CO 2: Explain the concepts of Īśvara, Guru Tattva, Avatara Tattva, and the Theory of Karma as foundational elements of Indian cultural philosophy - CO 3: Apply the knowledge of Purusharthas, Sanyasa, and Yajna to analyze real-life ethical and spiritual scenarios. - CO 4: Analyze the symbolism in cultural practices, Nataraja iconography, and temple architecture. - CO 5: Evaluate the significance of temples as cradles of culture and explore alternative systems in India's cultural landscape. - CO 6: Develop projects or presentations that highlight the essence of Sanatana Dharma, sadhana, and the cultural significance of symbols.

E. CO-PO Mapping: [affinity#: 3 – high; 2- moderate; 1- slightly]

COs	Program Outcomes [POs]												Program Specific Outcomes [PSOs]*	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO01	-	-	-	-	-	-	-	2	-	-	-	3	-	-
CO02	-	-	-	-	-	1	-	2	-	-	-	3	-	-
CO03	-	-	-	-	-	3	3	3	2	-	-	2	-	-
CO04	-	-	-	-	-	3	-	-	-	-	-	3	-	-
CO05	-	-	-	-	-	2	3	-	-	-	-	2	-	-
CO06	-	-	-	-	-	2	2	2	2	-	-	3	-	-
Total														
Average														

F. SYLLABUS

GLIMPSES OF INDIAN CULTURE

[P/F]

Course Syllabus

Chapter 1	-	What is Sanatana Dharma
Chapter 2	-	The Heritage of Scriptures
Chapter 3	-	The idea of Īśvara
Chapter 4	-	Guru Tattva and Avatara Tattva
Chapter 5	-	Theory of Karma
Chapter 6	-	Purusharthas
Chapter 7	-	Sanyasa
Chapter 8	-	Yajna
Chapter 9	-	Symbolism
Chapter 10	-	Understanding Nataraja
Chapter 11	-	Temples: The Cradle of Culture
Chapter 12	-	Other Heterodox Systems in India

GLIMPSES OF INDIAN CULTURE**Reference Books:**

The Eternal Truth by Mata Amritanandamayi Devi

Temples: Centers for Spiritual Practice by Mata Amritanandamayi Devi

All About Hinduism by Swami Sivananda

Art of God Symbolism by Swami Chinmayananda

Temples in India by Swami Sivananda

G. Evaluation Pattern: 60:40

Component	Weightage	Remarks
Internal	60	-
External	40	-
TOTAL	100	

23HU601**Career Competency I****L-T-P-C: 0-0-3-P/F****Prerequisite:**

An open mind and the urge for self-development, basic English language skills and knowledge of high school level arithmetic.

Course Objectives:

- Help students transit from campus to corporate and enhance their soft skills
- Enable students to understand the importance of goal setting and time management skills
- Support them in developing their problem solving and reasoning skills
- Inspire students to enhance their diction, grammar and verbal reasoning skills

Course Outcomes:

CO1: Soft Skills - To develop positive mindset, communicate professionally, manage time effectively and set personal goals and achieve them.

CO2: Soft Skills - To make formal and informal presentations with self-confidence.

CO3: Aptitude - To analyze, understand and employ the most suitable methods to solve questions on arithmetic and algebra.

CO4: Aptitude - To analyze, understand and apply suitable techniques to solve questions on logical reasoning and data analysis.

CO5: Verbal - To infer the meaning of words and use them in the right context. To have a better understanding of the nuances of English grammar and become capable of applying them effectively.

CO6: Verbal - To identify the relationship between words using reasoning skills. To understand and analyze arguments and use inductive/deductive reasoning to arrive at conclusions and communicate ideas/perspectives convincingly.

CO-PO Mapping

PO/CO	PO1	PO2	PO3
CO1	2	1	-
CO2	2	1	-
CO3	2	1	-
CO4	2	1	-
CO5	1	2	-
CO6	2	2	-

Syllabus:

Soft Skills

Introduction to ‘campus to corporate transition’:

Communication and listening skills: communication process, barriers to communication, verbal and non-verbal communications, elements of effective communication, listening skills, empathetic listening, role of perception in communication.

Assertiveness skills: the concept, assertiveness and self-esteem, advantages of being assertive, assertiveness and organizational effectiveness.

Self-perception and self-confidence: locus of control (internal v/s external), person perception, social perception, attribution theories-self presentation and impression management, the concept of self and self-confidence, how to develop self-confidence.

Goal setting: the concept, personal values and personal goals, goal setting theory, six areas of goal setting, process of goal setting: SMART goals, how to set personal goals

Time management: the value of time, setting goals/ planning and prioritizing, check the time killing habits, procrastination, tools for time management, rules for time management, strategies for effective time management

Presentation skills: the process of presentation, adult learning principles, preparation and planning, practice, delivery, effective use of voice and body language, effective use of audio visual aids, dos and don'ts of effective presentation

Public speaking-an art, language fluency, the domain expertise (Business GK, Current affairs), self-confidence, the audience, learning principles, body language, energy level and conviction, student presentations in teams of five with debriefing

Verbal

Vocabulary: Familiarize students with the etymology of words, help them realize the relevance of word analysis and enable them to answer synonym and antonym questions. Create an awareness about the frequently misspelt words, commonly confused words and wrong form of words in English.

Grammar: Train students to understand the nuances of English Grammar and thereby enable them to spot grammatical errors and punctuation errors in sentences.

Reasoning: Stress the importance of understanding the relationship between words through analogy questions and learn logical reasoning through syllogism questions. Emphasize the importance of avoiding the gap (assumption) in arguments/ statements/ communication.

Oral Communication Skills: Aid students in using the gift of the gab to improve their debating skills.

Writing Skills: Introduce formal written communication and keep the students informed about the etiquettes of email writing. Make students practise writing emails especially composing job application emails.

Aptitude

Numbers: Types, Power Cycles, Divisibility, Prime, Factors & Multiples, HCF & LCM, Surds, Indices, Square roots, Cube Roots and Simplification.

Percentage: Basics, Profit, Loss & Discount, and Simple & Compound Interest.

Ratio, Proportion & Variation: Basics, Alligations, Mixtures, and Partnership.

Averages: Basics, and Weighted Average.

Time and Work: Basics, Pipes & Cistern, and Work Equivalence.

Time, Speed and Distance: Basics, Average Speed, Relative Speed, Boats & Streams, Races and Circular tracks.

Statistics: Mean, Median, Mode, Range, Variance, Quartile Deviation and Standard Deviation.

Data Interpretation: Tables, Bar Diagrams, Line Graphs, Pie Charts, Caselets, Mixed Varieties, and other

forms of data representation.

Equations: Basics, Linear, Quadratic, Equations of Higher Degree and Problems on ages.

Logarithms, Inequalities and Modulus: Basics

References

Soft Skills:

Communication and listening skills:

- Andrew J DuRbin , “Applied Psychology: Individual and organizational effectiveness”, Pearson-Merril Prentice Hall, 2004
- Michael G Aamodt, “An Applied Approach, 6th edition”, Wadsworth Cengage Learning, 2010

Assertiveness skills:

- Robert Bolton, Dorothy Grover Bolton, “People Style at Work..and Beyond: Making Bad Relationships Good and Good”, Ridge Associates Inc., 2009
- John Hayes “Interpersonal skills at work”, Routledge, 2003
- Nord, W. R., Brief, A. P., Atieh, J. M., & Doherty, E. M., “Meanings of occupational work: A collection of essays (pp. 21- 64)”, Lexington, MA: Lexington Books, 1990

Self-perception and self-confidence:

- Mark J Martinko, “Attribution theory: an organizational perspective”, St. Lucie, 1995
- Miles Hewstone, “Attribution Theory: Social and Functional Extensions”, Blackwell, 1983

Time management:

- Stephen Covey, “The habits of highly effective people”, Free press Revised edition, 2004
- Kenneth H Blanchard , “The 25 Best Time Management Tools & Techniques: How to Get More Done Without Driving Yourself Crazy” , Peak Performance Press, 1st edition 2005
- Kenneth H. Blanchard and Spencer Johnson, “The One Minute Manager” , William Morrow, 1984

Verbal:

- Erica Meltzer, “The Ultimate Guide to SAT Grammar”
- Green, Sharon, and Ira K. Wolf, “Barron's New GRE”, Barron's Educational Series, 2011
- Jeff Kolby, Scott Thornburg & Kathleen Pierce, “Nova’s GRE Prep Course”
- Kaplan, “Kaplan New GRE Premier”, 2011-2012
- Kaplan’s GRE Comprehensive Programme
- Lewis Norman, “Word Power Made Easy”, Goyal Publishers, Reprint edition, 1 June 2011
- Manhattan Prep, “GRE Verbal Strategies Effective Strategies Practice from 99th Percentile Instructors”
- Pearson- “A Complete Manual for CAT”, 2013
- R.S. Aggarwal, “A Modern Approach to Verbal Reasoning”
- S. Upendran, “Know Your English”, Universities Press (India) Limited, 2015
- Sharon Weiner Green, Ira K. Wolf, “Barron's New GRE, 19th edition (Barron's GRE)”, 2019
- Wren & Martin, “English Grammar & Composition”
- www.bbc.co.uk/learningenglish
- www.cambridgeenglish.org
- www.englishforeveryone.org
- www.merriam-webster.com

Aptitude:

- Arun Sharma, “How to Prepare for Quantitative Aptitude for the CAT Common Admission Test”, Tata Mc Graw Hills, 5th Edition , 2012
- Arun Sharma, “How to Prepare for Logical Reasoning for the CAT Common Admission Test”, Tata Mc Graw Hills, 2nd Edition, 2014
- Arun Sharma, “How to Prepare for Data Interpretation for the CAT Common Admission Test”, Tata Mc Graw Hills, 3rd Edition, 2015
- R.S. Aggarwal, “Quantitative Aptitude For Competitive Examinations”, S. Chand Publishing, 2015
- R.S. Aggarwal, “A Modern Approach To Verbal & Non-Verbal Reasoning”, S. Chand Publishing, Revised -2015
- Sarvesh Verma, “Quantitative Aptitude-Quantum CAT”, Arihant Publications, 2016
- www.mbatious.com
- www.campusgate.co.in
- www.careerbless.com

Evaluation Pattern

Assessment	Internal	External
Continuous Assessment (CA)* – Soft Skills	30	-
Continuous Assessment (CA)* – Aptitude	10	25
Continuous Assessment (CA)* – Verbal	10	25
Total	50	50
Pass / Fail		

*CA - Can be presentations, speaking activities and tests.

23HU611

Career Competency II

L-T-P-C: 0-0-3-1

Pre-requisite: Willingness to learn, team spirit, basic English language and communication skills and knowledge of high school level arithmetic.

Course Objectives:

- Help students to understand the importance of interpersonal skills and team work
- Prepare the students for effective group discussions and interviews participation.
- Help students to sharpen their problem solving and reasoning skills
- Empower students to communicate effectively by using the correct diction, grammar and verbal reasoning skills

Course Outcomes:

CO1: Soft Skills - To demonstrate good interpersonal skills, solve problems and effectively participate in group discussions.

CO2: Soft Skills - To write technical resume and perform effectively in interviews.

CO3: Aptitude - To identify, investigate and arrive at appropriate strategies to solve questions on arithmetic by managing time effectively.

CO4: Aptitude - To investigate, understand and use appropriate techniques to solve questions on logical reasoning and data analysis by managing time effectively.

CO5: Verbal - To be able to use diction that is more refined and appropriate and to be competent in knowledge of grammar to correct/improve sentences

CO6: Verbal - To be able to examine, interpret and investigate passages and to be able to generate ideas, structure them logically and express them in a style that is comprehensible to the audience/recipient.

CO-PO Mapping

PO/CO	PO1	PO2	PO3
CO1	2	1	-
CO2	2	1	-
CO3	2	1	-
CO4	2	1	-
CO5	1	2	-
CO6	2	2	-

Syllabus

Soft Skills

Interpersonal skill: ability to manage conflict, flexibility, empathetic listening, assertiveness, stress management, problem solving, understanding one's own interpersonal needs, role of effective team work in organizations

Group problem solving: the process, the challenges, the skills and knowledge required for the same.

Conflict management: the concept, its impact and importance in personal and professional lives, (activity to identify personal style of conflict management, developing insights that helps in future conflict management situations.)

Team building and working effectively in teams: the concept of groups (teams), different stages of group formation, process of team building, group dynamics, characteristics of effective team, role of leadership in team effectiveness. (Exercise to demonstrate the process of emergence of leadership in a group, debrief and reflection), group discussions.

Interview skills: what is the purpose of a job interview, types of job interviews, how to prepare for an interview, dos and don'ts of interview, One on one mock interview sessions with each student

Verbal

Vocabulary: Help students understand the usage of words in different contexts. Stress the importance of using refined language through idioms and phrasal verbs.

Grammar: Enable students to identify poorly constructed sentences or incorrect sentences and improvise or correct them.

Reasoning: Facilitate the student to tap her/his reasoning skills through critical reasoning questions and logical ordering of sentences.

Reading Comprehension: Enlighten students on the different strategies involved in tackling reading comprehension questions.

Public Speaking Skills: Empower students to overcome glossophobia and speak effectively and confidently before an audience.

Writing Skills: Practice closet tests that assess basic knowledge and skills in usage and mechanics of writing such as punctuation, basic grammar and usage, sentence structure and rhetorical skills such as writing strategy, organization, and style.

Aptitude

Sequence and Series: Basics, AP, GP, HP, and Special Series.

Geometry: 2D, 3D, Coordinate Geometry, and Heights & Distance.

Permutations & Combinations: Basics, Fundamental Counting Principle, Circular Arrangements, and Derangements.

Probability: Basics, Addition & Multiplication Theorems, Conditional Probability and Bayes' Theorem.

Logical Reasoning I: Arrangements, Sequencing, Scheduling, Venn Diagram, Network Diagrams, Binary Logic, and Logical Connectives, Clocks, Calendars, Cubes, Non-Verbal reasoning and Symbol based reasoning.

Logical Reasoning II: Blood Relations, Direction Test, Syllogisms, Series, Odd man out, Coding & Decoding, Cryptarithmic Problems and Input - Output Reasoning.

Data Sufficiency: Introduction, 5 Options Data Sufficiency and 4 Options Data Sufficiency.

Campus recruitment papers: Discussion of previous year question papers of all major recruiters of Amrita Vishwa Vidyapeetham.

Miscellaneous: Interview Puzzles, Calculation Techniques and Time Management Strategies.

References

Soft Skills

Team Building

- Thomas L.Quick, "Successful team building", AMACOM Div American Mgmt Assn, 1992
- **Brian Cole Miller, "Quick Team-Building Activities for Busy Managers: 50 Exercises That Get Results in Just 15 Minutes", AMACOM; 1 edition, 2003.**
- **Patrick Lencioni, "The Five Dysfunctions of a Team: A Leadership Fable", Jossey-Bass, 1st Edition, 2002**

Verbal

- "GMAT Official Guide" by the Graduate Management Admission Council, 2019
- Arun Sharma, "How to Prepare for Verbal Ability And Reading Comprehension For CAT"
- Joern Meissner, "Turbocharge Your GMAT Sentence Correction Study Guide", 2012
- Kaplan, "Kaplan GMAT 2012 & 13"
- Kaplan, "New GMAT Premier", Kaplan Publishing, U.K., 2013
- Manhattan Prep, "Critical Reasoning 6th Edition GMAT"

- Manhattan Prep, “Sentence Correction 6th Edition GMAT”
- Mike Barrett “SAT Prep Black Book The Most Effective SAT Strategies Ever Published”
- Mike Bryon, “Verbal Reasoning Test Workbook Unbeatable Practice for Verbal Ability, English Usage and Interpretation and Judgement Tests”
- www.bristol.ac.uk/arts/skills/grammar/grammar_tutorial/page_55.htm
- www.campusgate.co.in

Aptitude

- Arun Sharma, “How to Prepare for Quantitative Aptitude for the CAT Common Admission Test”, Tata Mc Graw Hills, 5th Edition, 2012
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