AMRITA VISHWA VIDYAPEETHAM
DEEMED TO BE UNIVERSITY
School of Engineering

(AMRITAPURI, BENGALURU, COIMBATORE, CHENNAI)

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

M. Tech. in ELECTRICAL ENGINEERING

(Power Electronics & Drives, Electric Vehicle Technology, AI & IoT)

(MTC-EE)

CURRICULUM AND SYLLABI

(2025)

Program Outcomes (POs)

PO1: An ability to independently carry out research /investigation and development work to solve practical problems.

PO2: An ability to write and present a substantial technical report/document.

PO3: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program

Program Specific Outcomes (PSOs)

PSO1: To develop models and analyse power electronics/ Electric Vehicle/ IoT systems using modern engineering and computational tools

PSO2: To investigate research problems in power electronic and drives/ Electric Vehicle technology/ IoT and provide solutions using modern tools.

CURRICULUM

M.Tech. Electrical Engineering
Specialization in Power Electronics & Drives, Electric Vehicle Technology, AI & IoT

Duration: 2 years, Total 68 credits

I Semester

Course Code	Type	Course Title	L T P	Credits
25MA601	MAT – Foundation	Mathematics for Electrical Engineering	3 1 0	4
25EE601	EE – Foundation	Advanced Digital Signal Processing	3 0 3	4
25EE602	EE – Foundation	Embedded System Design and Control	3 0 3	4
25ES603	EE – Foundation	Machine Learning for Embedded Systems	3 0 3	4
	Specialization Core	Course I / Elective I	3 0 0/2 0 3	3
	Specialization Core	Course II* / Elective II	3 0 0/2 0 3	3
25RM602	EE – Subject Core	Research Methodology	2 0 0	2
23HU601	CIR – Humanities	Career Competency – I	0 0 3	P/F
22ADM501	AVP – Humanities	Glimpses of Indian Culture		P/F
			Total	**21/24**

II Semester

Course Code	Type	Course Title	L T P	Credits
	Specialization Core	Course II* / Elective II	3 0 0/2 0 3	3
	Specialization Core	Course III / Elective III	3 0 0/2 0 3	3
	Specialization Core	Course IV / Elective IV	3 0 0/2 0 3	3
	Specialization Core	Course V / Elective V	3 0 0/2 0 3	3
	Specialization Core	Course VI# / Elective VI	3 0 0/2 0 3	3
25EE681	Project	Open Lab	0 0 6	3
25EE698	Specialization Core	Industry Internship	0 0 3	1
25AVP501	Humanities	Mastery Over Mind	1 0 2	2
23HU611	CIR – Humanities	Career Competency – II	0 0 3	1
			Total	**16/19/22**

III Semester

Course Code	Type	Course Title	L T P	Credits
	Specialization Core	Course VI# / Elective VI	3 0 0/2 0 3	3
25EE798	Project	Dissertation I	0 0 30	10
			Total	**10/13**

IV Semester

Course Code	Type	Course Title	L T P	Credits
25EE799	Project	Dissertation II	0 0 45	**15**

* Offered either in Semester I or II; # Offered either in Semester II or III.

Specialization Core

Sl. No.	Specialization I Power Electronics & Drives	Specialization II Electric Vehicle Technology	Specialization III AI & IoT
1	25PE631Design and Analysis of Power Converters	25EV641 System Engineering for Electric Vehicle	25AI651 IoT & System Design
2	25PE632 Modelling and Analysis of Electrical Machines	25EV642 Vehicle Dynamics & Stability	25AI652 Deep Learning
3	25PE633 Advanced Power Converters and Control	25EV643 Vehicular Electronics & Driver Assistance Systems	25AI653 Intelligent Control
4	25PE634 Power Train Design and Control	25EV644 Automotive Systems and Layered Architecture	25AI654 Cyber Systems and Security
5	25EV641 System Engineering for Electric Vehicle	25ES637 Embedded Systems for Automotive Applications	25AI655 Cloud Computing and Big Data Analytics
6	25PE635 Power Components and Electromagnetic Compatibility	25PE632 Modelling and Analysis of Electrical Machines	25AI656 AI driven Renewable Energy
7	25PE636 Power Electronics for Renewable Energy and Microgrid Systems	25PE634 Power Train Design and Control	25AI657 Smart Grid & Technologies
8	25PE637 Condition Monitoring and Predictive Maintenance	25EV645 Battery Management & Charging Systems	25AI658 Wide Area Monitoring and Control
9	25EV645 Battery Management & Charging Systems	25AI655 Cloud Computing and Big Data Analytics	25AI659 Energy Markets and Blockchain
10	25AI651 IoT & System Design	25AI651 IoT & System Design	25AI660 Hardware-in-Loop and Digital Twin
11	25AI660 Hardware-in-Loop and Digital Twin	25AI660 Hardware-in-Loop and Digital Twin	25EV646 ADAS & AUTOSAR
12	25AI652 Deep Learning	25AI652 Deep Learning	25EV645 Battery Management & Charging Systems
13	25AI653 Intelligent Control	25PE637 Condition Monitoring and Predictive Maintenance	25PE637 Condition Monitoring and Predictive Maintenance

Credit Analysis

Type	Credit	% Share	Common/Specialization
Foundation – Common	16	24.62%	32.31

Mandatory Courses – Common	05	7.69%	
Specialization Specific	18	27.69%	67.69
Project – Individual	26	40.00%	
	65	**100**	**100**

Electives

Course Code	Course Title	L T P	Credits
25PE631	Design and Analysis of Power Converters	2 0 3	3
25PE632	Modelling and Analysis of Electric Machines	3 0 0	3
25PE633	Advanced Power Converters and Control	2 0 3	3
25PE634	Power Train Design and Control	2 0 3	3
25PE635	Power Components and Electromagnetic Compatibility	2 0 3	3
25PE636	Power Electronics for Renewable Energy and Microgrid Systems	2 0 3	3
25PE637	Condition Monitoring and Predictive Maintenance	2 0 3	3
25EV641	System Engineering for Electric Vehicle	2 0 3	3
25EV642	Vehicle Dynamics & Stability	3 0 0	3
25EV643	Vehicular Electronics & Driver Assistance Systems	3 0 0	3
25EV644	Automotive Systems and Layered Architecture	2 0 3	3
25ES637	Embedded Systems for Automotive Applications	2 0 3	3
25EV645	Battery Management & Charging Systems	2 0 3	3
25EV646	ADAS & Autosar	2 0 3	3
25AI651	IoT & System Design	2 0 3	3
25AI652	Deep Learning	2 0 3	3
25AI653	Intelligent Control	2 0 3	3
25AI654	Cyber Systems and Security	3 0 0	3
25AI655	Cloud Computing and Big Data Analytics	3 0 0	3
25AI656	AI driven Renewable Energy	3 0 0	3
25AI657	Smart Grid & Technologies	3 0 0	3
25AI658	Wide Area Monitoring and Control	3 0 0	3
25AI659	Energy Markets and Blockchain	3 0 0	3
25AI660	Hardware-in-Loop and Digital Twin	2 0 3	3

SYLLABUS

SEMESTER I

25MA601	Mathematics for Electrical Engineering	L-T-P-C: 3-1-0-4

Pre-requisite: Nil

Course Objectives

- Understand the basic concepts of vector space, subspace, basis and dimension. Understand and apply linear transform for various matrix decompositions.
- To analyse and solve ordinary differential equations (ODE) and to analyse stability of systems of first order ordinary differential equations.
- Familiarise the basic concepts in statistics and apply to engineering problems.
- Understand the different methods for single and multivariable optimization problems.

Course Outcomes

CO1: To understand the basic concepts of vector space, subspace, basis and dimension. Also to Understand the apply different matrix decompositions.
CO2: To understand and apply differential equations into electrical engineering problems.
CO3: To understand and apply statistical hypotheses testing for small and large data.
CO4: To solve the difference equations using Z-Transform and apply to discrete single problems
CO5: To use single and multivariable optimization models for solving multi-object models.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4/PSO1	PO5/PSO2
CO1	3	-	2	1	2
CO2	3	-	2	1	2
CO3	3	-	**1**	1	1
CO4	3	-	2	1	1
CO5	3	-	3	1	2

Syllabus:

Differential Equations: First-order, second-order, homogeneous, non-homogeneous, RLC circuits, damping, resonance, solution methods, Review of Laplace Transforms and Fourier series and transforms with applications.
System Modeling: State-space, transfer function, controllability, observability, Basic non-linear system models.
Z-transform and Discrete-Time Systems: Inverse Z-transform – Z-transform solution of difference equations – Discrete-time system analysis – Applications in digital control systems.
Linear Algebra: Vector spaces, Linear Transformation, Eigenvalues and Eigenvectors, diagonalization, Matrix decompositions LU, QR, and SVD.
Probability & Statistics: Bayes' theorem, random variables, distributions, expectation, variance, hypothesis testing.
Optimization: Single and Multivalued optimizations. Introduction to Convex optimization, Linear Programming Basic duality concepts.
Numerical modelling Studies using MATLAB/Simulink and Python

Textbooks/References

1. Erwin Kreyszig, "*Advanced Engineering Mathematics"*, Wiley, 10th Edition, 2011.
2. Chi-Tsong Chen, "*Linear System Theory and Design"*, Oxford University Press, 4th Edition, 2013.
3. Sheldon M. Ross, "*Probability and Statistics for Engineers and Scientists"*, Academic Press, 5th Edition, 2014.
4. Gilbert Strang, "*Linear Algebra and Its Applications"*, Cengage Learning, 4th Edition, 2006.
5. William Flannery, "*Mathematical Modeling and Computational Calculus*", Vol-1, Berkeley Science Books, 2013.
6. Stephen Boyd and Lieven Vandenberghe, "*Convex Optimization*", Cambridge University Press, 2018.
7. Gilbert Strang, "*Linear Algebra and Learning from Data*", Wellesley-Cambridge Press, 2019.

25EE601	Advanced Digital Signal Processing	L-T-P-C: 3-0-3-4

Pre-requisite: Nil

Course Objective

- To apply digital signal processing techniques to analyze, model, and simulate electrical systems.
- To design and implement advanced filters and multirate methods for real-time signal processing applications.

Course Outcomes

CO1: Analyze sampling, aliasing, FFT, and implement IIR/FIR filters using MATLAB.

CO2: Apply signal processing methods to model, simulate, and solve problems in electrical networks and systems.

CO3: Analyze and implement advanced digital filters such as Adaptive Filters and Kalman Filters for real-time applications.

CO4: Demonstrate the principles of multirate signal processing and discrete wavelets as filter banks in electrical systems.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4/PSO1	PO5/PSO2
CO1	2	1	3	2	1
CO2	2	1	3	2	1
CO3	2	1	2	2	1
CO4	2	1	2	1	1

Syllabus

Review of Signal Processing Techniques – Adaptive Filters (Four basic types), Estimation Theory, Multirate Digital Signal Processing Basic Concepts. Introduction to Wavelet Transforms—Discrete Wavelet Transforms- Discrete Wavelets and Filter Banks. Introduction to Kalman Filter and Variations. Applications.

– Two dimensional signals and systems–Sampling in two dimensions–Two dimensional discrete transforms— DCT –DWT– Applications–2D Hadamard Transform, Walsh Transform, KLT, Application – Z Transform and its properties –Image Acquisition– *Enhancement-* Filtering in Spatial and Frequency domain. *Morphological operations, Image segmentation, Feature Extraction,* Image Compression – 3D signals and Systems–3D sampling and reconstruction–Digital Video Processing – Case Studies

Textbooks/References

1. Rafael C. Gonzalez, “Digital Image Processing”, Third Edition, PHI Private Limited, New Delhi, 2008.
2. John W. Wood, “Multidimensional Signal, Image, Video Processing and Coding”, Elsevier, 2006.
3. Mitra S.K., “Digital Signal Processing, A Computer-Based Approach”, 4th Edition, McGraw-Hill, 2013.
4. Ifeachor E. C. and Jervis B. W., “Digital Signal Processing: A Practical Approach”, 2nd Edition, Pearson Education, 2009.
5. Vaidyanathan P. P, “Multirate Systems and Filter Banks”, Prentice Hall, 1993.
6. Simon Haykin, “Adaptive Filter Theory”, 4th Edition, Pearson Education, 2008.

25EE602	Embedded System Design and Control	L-T-P-C: 3-0-3-4

Pre-requisite: Nil

Course Objectives

- To impart fundamental knowledge of embedded systems, focusing on ARM Cortex microcontroller architecture, peripheral programming, and application development.
- To develop competency in programming TMS320F28335 Delfino DSP for real-time control, signal processing, and PWM-based applications.
- To enable students to design and implement sensor interfacing, real-time data acquisition, and DSP-based control strategies for power converters and electric drive applications.

Course Outcomes

CO1: Understand the architecture, peripherals, and application development process of ARM Cortex microcontrollers
for embedded system design.

CO2: Understand the architecture, peripherals, and application development process of TMS320F28335 Delfino DSP.

CO3: Develop embedded C programs for real-time control applications using ARM Cortex microcontroller & TMS320F28335 Delfino DSP.

CO4: Design and implement real world automation solutions using embedded systems.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4/PSO1	PO5/PSO2
CO1	1		3	2	
CO2	2	2	3	3	2
CO3	3	**2**	**3**	3	3
CO4	3	2	3	3	3

Syllabus

Introduction to embedded systems – Hardware & Software Components. Embedded system design process. Architecture of ARM Cortex Microcontroller – Peripherals – Ports, Timers, PWM, ADC, UART, SPI, I2C – Application development – Bare-metal Programming, Rapid Prototyping with libraries.

Architecture of TMS320F28335 Delfino Digital Signal Processor – Code Composer Studio development environment – Embedded C programming of GPIO – Timers – Enhanced PWM (ePWM) – QEP – CAN – Implementation of sine PWM and space vector PWM.

Interfacing analog and digital sensors – Real-time waveform acquisition and data display – Basic motor control using PWM – Real-time waveform sampling and PI-based closed-loop control – Speed and position control using QEP feedback - Pulse generation techniques for various power converters – DSP-based control for electric drive applications – Case studies from industrial automation, electric vehicles, or renewable energy systems.

Textbooks/References

1. ARM Cortex Microcontroller Reference Manual.
2. TMS320F28335 Delfino Technical Reference Manual.
3. Raj Kamal, *"Microcontrollers: Architecture, Programming, Interfacing and System Design"*, 2nd Edition, Pearson Education, 2011.

4. Michael D. Tidwell, *"Digital Signal Processing and Applications with the TMS320F28335"*, 1st Edition, Wiley, 2009.
5. Carmine Noviello, "*Mastering STM32*", 1st Edition, Independently Published, 2017
6. B Venkataramani and M Bhaskar, "Digital Signal Processors: Architecture, Programming and Applications", 2nd Edition Tata McGraw Hill, 2017.
7. Donald Norris, "*Programming with STM32: Getting Started with the Nucleo Board and C/C++*", 1st Edition, McGraw-Hill Education, 2018.

25ES603	Machine Learning for Embedded Systems	L-T-P-C:3-0-3-4

Pre-requisite: Nil

Course Objectives

- To introduce foundational concepts in machine learning and their relevance to embedded systems.
- To develop practical skills for designing, training, and deploying ML models using platforms like Edge Impulse.
- To explore model optimization and deployment strategies tailored for resource-constrained embedded environments.

Course Outcomes

CO1: Explain key machine learning concepts and evaluate models using appropriate metrics for classification, regression, and anomaly detection.

CO2: Apply algorithms such as SVMs, neural networks, and CNNs to solve classification and regression problems using embedded datasets.

CO3: Build end-to-end ML applications on Edge Impulse, including data acquisition, feature engineering, model training, and validation.

CO4: Optimize and deploy trained models to embedded platforms using frameworks such as TensorFlow Lite and TFLM, considering hardware constraints and sensor fusion.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4/PSO1	PO5/PSO2
CO1	2	2	3		2
CO2	2	-	3	2	2
CO3	3	2	3	3	3
CO4	3	-	3	3	3

Syllabus

Review of Machine Learning Basics: learning types, classification/regression, model types, dimensionality issues, linear/logistic regression. Evaluation metrics for classification, regression, and anomaly detection. TinyML overview and key use cases.

Support vector machines for regression and classification. Neural Networks, Ensemble methods, Introduction to Convolutional Neural Network (CNN), Reinforcement Learning. End-to-end development of ML applications using Edge Impulse: data collection from sensors, Data pre-processing, feature extraction, feature selection, model training.

Model optimization techniques for embedded ML: quantization, pruning, model size vs performance trade-offs. Hardware constraints and selection criteria for ML deployment. Multi-sensor fusion. Deployment frameworks: TensorFlow Lite, TensorFlow Lite for Microcontrollers (TFLM).

Textbooks/References

1. *Pete Warden, Daniel Situnayake, TinyML: Machine Learning with TensorFlow Lite on Arduino and Ultra-Low-Power Microcontrollers, O'Reilly Media, 2020.*
2. *Simon Haykin, Neural Networks and Learning Machines, Pearson, 2020.*

3. *Xiaofei Wang, Yi Pan, Edge AI: Machine Learning for Embedded Systems, Springer, 2022.*
4. *Daniel Situnayake, Ian Buckley, Practical TinyML: Deploying Machine Learning on Microcontrollers with TensorFlow Lite, O'Reilly Media, 2022.*

Tom M. Mitchell, "Machine Learning", McGraw-Hill, 1 st edition 1997.

25RM602	RESEARCH METHODOLOGY	L-T-P-C: 2-0-0-2

Course Objectives

- To enable students to define research problems, review, analyse as well as to evaluate literature and possibly to formulate effective solutions.
- To prepare students either for a research thesis or for an industry-based project.
- To provide oral and written communication skills.
- To inculcate a strict adherence to the principles of research ethics and values

Course Outcomes

CO1: Understand the basic concepts of research and its methodologies

CO2: Understand and apply the process of searching for, selecting and critically analysing research articles and papers

CO3: Formulate and evaluate research questions and apply the process of designing a research study and interpreting

the outcomes of the study

CO4: Write and present a research report and thesis.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4/PSO1	PO5/PSO2
CO1	1	-	-	-	-
CO2	1	3	-	-	-
CO3	1	3	-	-	-
CO4	-	3	-	-	-

Syllabus

Meaning of Research, Types of Research, Research Process, Problem definition, Objectives of Research, Research Questions, Research design, Approaches to Research - Quantitative vs. Qualitative Approach, Understanding Theory, Building and Validating Theoretical Models, Exploratory vs. Confirmatory Research, Experimental vs Theoretical Research, Importance of reasoning in research.

Problem Formulation, Understanding Modeling & Simulation, Conducting Literature Review, Referencing, Information Sources, Information Retrieval, Role of libraries in Information Retrieval, Tools for identifying literatures, Indexing and abstracting services, Citation indexes

Experimental Research: Cause effect relationship, Development of Hypothesis, Measurement Systems Analysis, Error Propagation, Validity of experiments, Statistical Design of Experiments, Field Experiments, Data/Variable Types & Classification, Data collection, Numerical and Graphical Data Analysis: Sampling, Observation, Surveys, Inferential Statistics, and Interpretation of Results

Preparation of Dissertation and Research Papers, Guidelines for writing the abstract, introduction, methodology, results and discussion, conclusion sections of a manuscript. References, Tables and illustrations and Citation.

Intellectual property rights (IPR) – patents – copyrights - Trademarks - Ethics of Research, Scientific Misconduct - Forms of Scientific Misconduct – Plagiarism - Unscientific practices in thesis work.

Textbooks/References

1. Bordens, K. S. and Abbott, B. B., “Research Design and Methods – A Process Approach”, 11th Edition, McGraw-Hill, 2022.
2. Roy Sabo and Edward Boone, “Statistical Research Methods: A Guide for Non Statisticians”, Springer, 2013.
3. Davis, M., Davis K., and Dunagan M., “Scientific Papers and Presentations”, 3rd Edition,Elsevier Inc., 2013.
4. Ron Iphofen (Ed), “Handbook of Research Ethics and Scientific Integrity”, Springer, 2020.
5. Elsevier, “Ethics in Research & Publication”, https://www.elsevier.com/data/assets/pdf_file/0008/653885/Ethics-in-research-and-publication-brochure.pdf

23HU601	CAREER COMPETENCY I	L-T-P-C: 0-0-3-P/F

Pre-requisite

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.
C05: 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.
C06: 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/PSO / CO	PO1	PO2	PO3	PO4/PSO1	PO5/PSO2
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**

SEMESTER II

25EE681	OPEN LAB	L-T-P-C: 0-0-6-3

Course Objective

- To empower with practical experience to reinforce theoretical concepts, through demonstrational setup using modern tools.

Course Outcomes

CO1: Solve real time problems through the acquired theoretical knowledge in core courses.
CO2: Manage the time and cost of the product development.
CO3: Communicate the scientific findings through oral and writing modes with clarity and justification.
CO4: Utilize the advanced tools.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4/PSO1	PO5/PSO2
CO1	3	-	2	3	3
CO2	-	2	-	-	-
CO3	-	3	-	-	-
CO4	2	-	3	3	3

Syllabus

This is a hands – on section for the students. By the second semester, the students get adept to different core streams like Power Electronics, Electric Vehicle, AI and IoT etc. The students will apply their acquired knowledge and develop an application related to one or more of the core areas and implement a pragmatic setup, justifying the application.

25EE698	INDUSTRY INTERNSHIP	L-T-P-C: 0-0-3-1

Course Objectives

- To expose the students to industry setting and get acquainted with its various functions.
- To gain direct experience so as to relate and reinforce the concepts learned in the class room
- To promote collaboration between industry/Research Laboratory and the institution

Course Outcomes

CO1: Familiarize with the industry environment/Research Laboratory
CO2: Understand the application of theoretical concepts in a practical setting.
CO3: Prepare technical documents/presentations related to the work completed

CO-PO Mapping

PO/PSO	PO1	PO2	PO3	PO4/PSO1	PO5/PSO2

CO					
CO1	2	-	1	2	3
CO2	2	-	1	2	3
CO3	-	3	-	-	-

Syllabus

Students have to undergo a minimum of two weeks of practical training in Power Electronics & Drives/ Electric Vehicle Technology/AI & IoT or allied 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.

Evaluation Pattern

This course is mandatory. The student shall make a report. The committee constituted by the department which will assess the student based on the report submitted

25AVP501	MASTERY OVER MIND	L-T-P-C: 1-0-2-2

Course Objectives

- Mastery Over 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).
- It gives an introduction to immediate and long-term benefits of MA OM meditation and equips every attendee to manage stressful emotions and anxiety, in turn facilitating inner peace and harmony.
- This course will enhance the understanding of experiential learning based on the 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 Outcomes

CO1: Describe what meditation is and to understand its health benefits.
CO2: Understand the causes of stress and how meditation improves well-being.
CO3: Understand the science of meditation.
CO4: Learn and practice MA OM meditation in daily life.
CO5: Understand the application of meditation to improve communication and relationships.
CO6: Understand the power of meditation in compassion-driven action.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4/PSO1	PO5/PSO2
CO1	-	-	-	-	-
CO2	-	-	-	-	-
CO3	-	-	-	-	-
CO5	-	-	-	-	-
CO6	-	-	-	-	-

Syllabus

Describe Meditation and Understand its Benefits

A: Importance of meditation. How does meditation help to overcome obstacles in life (Pre-recorded video with Swami Shubhamritananda Puri).
Reading 1: Why Meditate? (Swami Shubamritananda ji).
Reading 2: 'Stillness of the Mind' Chapter 17 in Amritam Gamaya (2022). MataAmritanandamayi Mission Trust.
Additional Reading: Abhyasa Yoga: The Yoga of Practice. (Br. Achyutamrita Chaitanya).
B: Understand how meditation works. Understand how meditation helps in improving physical and mental health. Understand how meditation helps in the development of personality (Pre-recorded video with Dr. Ram Manohar).
Reading 1: Allen, Cynthia (2020) The Potential Health Benefits of Meditation.
Additional Reading: Sharma, Hari (2022) Meditation: Process and Effects.

Causes of Stress and How Meditation Improves Well-being

A: Learn how to prepare for meditation. Understand the aids that can help in effectively practicing meditation. Understand the role of sleep, physical activity, and a balanced diet in supporting meditation. (Pre-recorded video with Dr. Ram Manohar).

B: Causes of Stress. The problem of not being relaxed. Effects of stress on health. How meditation helps to relieve stress. Basics of stress management at home and the workplace. (Pre-recorded video with Prof Udhaykumar).
Reading 1: Mayo Clinic Staff (2022, April 29). Meditation: A Simple, Fast Way to Reduce Stress. Mayo Clinic. https://www.mayoclinic.org/tests-procedures/meditation/in-depth/meditation/art-20045858 (PDF provided).
22AVP103 MASTERY OVER MIND L-T-P-C: 1-0-2-2
Reading 2: 'Efficient Action.' Chapter 28 in Amritam Gamaya (2022). MataAmritanandamayi Mission Trust.

The Science of Meditation

A: A preliminary understanding of the Science of meditation. What can modern science tell us about this traditionbased method? (Pre-recorded video with Dr. Shyam Diwakar).
B: How meditation helps humanity according to what we know from scientific research.
(Pre-recorded video with Dr. Shyam Diwakar)
Reading 1: Does Meditation Aid Brain and Mental Health (Dr Shyam Diwakar)
Reading 2: 'Science and Spirituality.' Chapter 85 in Amritam Gamaya (2022). MataAmritanandamayi Mission Trust.

Practicing MA OM Meditation in Daily Life

Guided Meditation Sessions following scripts provided (Level One to Level Five).
Reading 1: MA OM and White Flower Meditation: A Brief Note (Swami AtmanandaPuri).
Reading 2: 'Live in the Present Moment.' Chapter 71 in Amritam Gamaya (2022). MataAmritanandamayi Mission Trust.

Improving Communication and Relationships

How meditation and mindfulness influence interpersonal communication. The role ofmeditation in improving relationship quality in the family, at the university and in theworkplace. (Pre-recorded video with Dr Shobhana Madhavan).
Reading 1: Seppala E (2022, June 30th) 5 Unexpected Ways Meditation Improves Relationships a Lot. Psychology Today. https://www.psychologytoday.com/intl/blog/feeling-it/202206/5-unexpected-waysmeditation-improves-relationships-lot.
Reading 2: 'Attitude.' Chapter 53 in Amritam Gamaya (2022). Mata Amritanandamayi Mission Trust.

Meditation and Compassion-driven Action

Understand how meditation can help to motivate compassion-driven action. (Pre-recorded video with Dr Shobhana Madhavan).
Reading 1: Schindler, S., & Friese, M. (2022). The relation of mindfulness and prosocialbehavior: What do we (not) know?. Current Opinion in Psychology, 44, 151-156.
Reading 2: 'Sympathy and Compassion.' Chapter 100 in Amritam Gamaya (2022). MataAmritanandamyi Mission Trust.

Textbooks/References

1. Meditation and Spiritual Life-Swami Yatiswarananda, Ramakrishna Math.
2. The Complete Works of Swami Vivekananda Vol Vii by Advaita Ashram Mayavati Almora Himalayas.
3. Dhyana Yoga-Holy Gita Swami Chinmayanda.
4. Voice of God, Chandrasekharendra Saraswati, 68th Acharya of Sri Kanchi Kamakoti Peetam.
5. Hindu Dharma-Chandrasekharendra Saraswati, 68th Acharya of Sri Kanchi Kamakoti Peetam.
6. Mind: It's Mysteries and control-Swami Sivananda Saraswati.
7. Amritam Gamaya (2022). Mata Amritanandamayi Mission Trust.
8. Books on Amma's teachings like Awaken children, From Amma's Heart etc.
9. The Science of Meditation: How to Change Your Brain, Mind and Body by Daniel Goleman and Richard. J. Davidson.
10. Allen, Cynthia (2020) The Potential Health Benefits of Meditation.
11. Seppala E (2022, June 30th Unexpected Ways Meditation Improves Relationships a Lot.Psychology Today.

12. Sharma, Hari (2022) Meditation: Process and Effects.
13. Mayo Clinic Staff (2022, April 29). Meditation: A Simple, Fast Way to Reduce Stress
14. Schindler, S., & Friese, M. (2022). The relation of mindfulness and prosocial behaviour: What do we (not) know? Current Opinion in Psychology, 44, 151-156.

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.

C05: 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

C06: 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/PSO / CO	PO1	PO2	PO3	PO4/PSO1	PO5/PSO2
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, Cryptarithmetic 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", JosseyBass, 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
- 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, 3nd 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

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

SEMESTER III

25EE798	DISSERTATION I	L-T-P-C: 0-0-30-10

Course Objectives

The students are made to choose a suitable problem, comprehend and analyse the problem after a detailed literature survey.

Course Outcomes

CO1: Identify a topic based on recent literature in power electronics and drives / electric vehicle technology / AI and IoT

CO2: Formulate the framework for implementation.

CO3: Choose computational and analytical tools for implementation

CO4: Communicate technical content orally and document the findings

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4/PSO1	PO5/PSO2
CO1	3	-	3	2	2
CO2	3	-	3	3	3
CO3	3	-	3	3	3
CO4	-	3	2	-	-

SEMESTER IV

25EE799	DISSERTATION II	L-T-P-C: 0-0-45-15

Course Objectives

The students are made to work on the problem selected and comprehend and analyse the results.

Course Outcomes

CO1: Plan the project implementation with power electronics and drives / electric vehicle technology / AI and IoT domain knowledge

CO2: Implementation of project methodology in software/hardware aspects

CO3: Analyse the results and perform comparative analysis with existing frameworks.

CO4: Prepare technical reports, research papers, and disseminate knowledge.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4/PSO1	PO5/PSO2
CO1	3	-	3	3	3
CO2	3	-	3	3	3
CO3	3	-	3	3	3
CO4	-	3	2	-	-

SPECIALIZATION ELECTIVE: Power Electronics & Drives

25PE631	Design &Analysis of Power Converters	L-T-P-C: 2-0-3-3

Pre-requisite: Nil

Course Objectives

- To understand the static and dynamic behavior of power semiconductor devices and wide band gap technologies, along with the integration of power modules for efficient conversion systems.
- To equip students with the knowledge and hands-on skills to design, simulate, and implement power electronic converters using appropriate PWM strategies for real-world applications

Course Outcomes

CO1: Analyze the static and dynamic characteristics of fundamental power semiconductor devices, power modules and wide band gap devices

CO2: Analyze techniques to design and assess the performance of power converters such as AC-DC converters, AC-AC converters and DC-AC inverters

CO3: Apply PWM techniques for various converters

CO4: Design, simulate, and test various power conversion circuits in the laboratory and their corresponding PWM techniques

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4/PSO1	PO5/PSO2
CO1	2	1	2	2	-
CO2	2	1	2	2	1
CO3	2	1	2	2	-
CO4	2	3	2	2	1

Syllabus

Overview of power semiconductor devices – I-V and switching characteristics: Power BJT - Thyristors - Power Diodes – MOSFET - IGBT - Introduction to Intelligent Power Modules (IPM) and Wide band gap power semiconductor devices, device selection criteria (SiC and GaN technologies). *Thermal & Loss Analysis: Loss evaluation, heat sink design*, non-sinusoidal waveform power computation. DC-DC Converters - Buck, Boost – design and analysis, continuous and Voltage Source Inverters (single/three-phase), square wave, sinusoidal PWM, harmonic distortion and filtering, power factor correction. AC-DC Converters - Uncontrolled rectifiers (single/three-phase), performance parameters, bidirectional converters, Applications of Power converters in EVs, renewable energy, UPS, data centres.

Design and Analysis of Power Converters using PSIM/LTSPICE, MATLAB.

Textbooks/References

1. Ned Mohan, Tore M. Undeland and William P. Robbins, “Power Electronics, Converters, Applications and Design”, Third Edition, John Wiley and Sons Inc., 2006.
2. L. Umanand, “Power Electronics: Essentials and Applications”, Wiley India, 2009.
3. Joseph Vithayathil “Power Electronics” Tata McGraw Hill, 2010

4. Muhammed H Rashid, “Power Electronics- circuits, devices and applications” Pearson Education; Fourth edition 2017.
5. Daniel W Hart, “Power Electronics”, Tata McGraw Hill, 2011.
6. Robert W Erickson, Maksimovic, and Dragan “Fundamentals of Power Electronics”, Springer International, 2020.
7. V. Ramanarayanan, “Course Material on Switched Mode Power Conversion”, Department of Electrical Engineering, Indian Institute of Science, Bangalore. http://minchu.ee.iisc.ernet.in/new/people/faculty/vr/book.pdf

25PE632	Modelling and Analysis of Electrical Machines	L-T-P-C: 3-0-0-3

Pre-requisite: Nil

Course Objective

- To understand electromechanical energy conversion and model DC/AC machines in steady and transient states.
- To apply reference frame theory and simulate dynamic behaviour of electrical machines.

Course Outcomes:

CO1: Review the principles of electro-mechanical energy conversion

CO2: Formulate the mathematical model of DC and AC Machines for transient and steady state conditions

CO3: Apply reference frame theory to AC machines

CO4: Analyze the dynamic behaviour of AC & DC machines using Simulation Tools

CO-PO Mapping:

PO/PSO / CO	PO1	PO2	PO3	PO4/PSO1	PO5/PSO2
CO1	2	1	3	2	-
CO2	2	1	3	2	-
CO3	2	1	3	2	1
CO4	2	1	3	2	1

Syllabus

Principles of electromagnetic energy conversion: General expression of stored magnetic energy, co-energy and force/torque, single and doubly excited system; Calculation of air gap mmf and per phase machine inductance, Three phase symmetrical induction machines and salient pole synchronous machines in phase variable form.

Generalized theory of rotating electrical machine and Kron’s primitive machine; modelling, steady state and transient analysis of DC machines, Introduction to reference frame theory, Application of reference frame theory to three phase symmetrical induction and synchronous machines, modelling, steady state and transient analysis of induction machines, Unbalanced operation and fault analysis in three phase induction motors. Steady state and transient analysis of synchronous machines, standard and derived machine time constants, Transient power angle curves. Simulation Analysis using MATLAB/Simulink, ANSYS

Textbooks/References

1. C. Krause, “Analysis of Electric Machines and Drive Systems”, Wiley International, 2013.

2. T.A. Lipo, “Electrical Machine Analysis and Simulation”, John Wiley & Sons, 2009
3. B. Adkins, “Generalized Machine Theory”, McGraw Hill Book Company, 1964.
4. Bimbhra P S, “Generalized Theory of Electrical Machines”, Khanna Publishers, 2017.
5. Valeria Hrabovcova, Pavol Rafajdus, Pavol Makys, “Analysis of Electrical Machines”, IntechOpen Publishers, 2020.

25PE633	Advanced Power Converters and Control	L-T-P-C: 2-0-3-3

Pre-requisite: Design &Analysis of Power Converters

Course Objective

- To understand and analyze various power electronic converters and their performance characteristics.
- To design, simulate, and test converter circuits with PWM techniques.

Course Outcomes

CO1: Analyse and design the operation of DC-DC converters
CO2: Analyze techniques to design and assess the performance of power converters such as AC-DC Converters, AC-AC converters, and AC-DC inverters
CO3: Assess power quality, power factor, and harmonic issues of various power electronic converters
CO4: Design, simulate, and test various power conversion circuits in the laboratory and their corresponding PWM techniques.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4/PSO1	PO5/PSO2
CO1	2	-	3	2	1
CO2	2	-	3	2	1
CO3	2	-	**3**	2	1
CO4	1	3	3	2	1

Syllabus

DC/DC Converters – discontinuous conduction modes, voltage mode vs current mode control - closed loop control – buck converter – transfer function – time domain – frequency domain – four quadrant converter – SEPIC – multiport – flyback – forward – push-pull – half bridge – full bridge – soft switching – bidirectional converter – resonant – quasi resonant – ZVS – ZCS – PSFBC – DAB
DC/AC Converters – voltage source inverter – current-regulated PWM, grid synchronization, synchronous reference frame, hysteresis control, space vector PWM – DC side current – model predictive control – grid synchronization – synchronous reference frame – hysteresis control – three phase inverter-modelling
AC/DC Converters – uncontrolled rectifier – PFC converter – single phase – three phase – performance parameters – rectifier mode – inverter mode – G2V - V2G – PLL – active filtering
Multilevel Inverters – NPC-inverter – cascaded-multilevel – matrix converter

Textbooks/References

1. Ned Mohan, Tore M. Undeland, and William P. Robbins, “Power Electronics, Converters, Applications and Design”, Third Edition, John Wiley and Sons Inc., 2006.
2. Robert W Erickson and Dragan Maksimovic, “Fundamentals of Power Electronics”, Springer International,

2001.
3. Daniel W Hart, “Power Electronics”, Tata McGraw Hill, 2011.
4. John G. Kassakian, Martin F. Schlecht, and George C. Verghese, “Principles of Power Electronics”, Pearson, 2010.
5. V. Ramanarayanan, “Course Material on Switched Mode Power Conversion”, Department of Electrical Engineering, Indian Institute of Science, Bangalore. http://minchu.ee.iisc.ernet.in/new/people/faculty/vr/book.pdf

25PE634	Power Train Design and Control	L-T-P-C: 2-0-3-3

Pre-requisite: Modelling and Analysis of Electrical Machines

Course Objective

- To provide students with a comprehensive understanding of modern and advanced control strategies used in electric drives and their application to AC and special machines.
- To implement and evaluate control strategies for electric drives using simulation tools.

Course Outcomes

CO1: Understand the operation of modern control strategies used in electric drives.
CO2: Analyze the performance of advanced control strategies used in AC drives
CO3: Discuss the working and control of special electric machines
CO4: Implement the control techniques for electric drives in simulation environment

CO-PO Mapping:

PO/PSO / CO	PO1	PO2	PO3	PO4/PSO1	PO5/PSO2
CO1	2	-	3	1	-
CO2	2	-	3	2	1
CO3	1	-	2	1	-
CO4	2	1	2	2	1

Syllabus

Overview of Power Train Architectures – Energy Sources – Power Transmission Systems – Load. Electric Drive systems - Mechanical dynamics and multi-quadrant operation - stability and power rating – Load characteristics- Thermal models of electrical machines. Determination of motor rating based on thermal performance.
Induction Motor Drive – steady state equivalent circuit – phasor diagram – variable frequency supply – V/f control – voltage source inverter – constant air gap flux – field weakening -Field Oriented Control – space vector – direct orientation – indirect orientation – stator flux – rotor flux – airgap flux – flux torque decoupling direct torque control – flux observer – speed observer – sensorless control – Induction Generator – slip power recovery – static kramer – static scherbius – DFIM – modes of operation – equivalent circuit – active power control – reactive power control – vector control – Synchronous Motor Drive – equivalent circuit – starting – phasor diagram – power factor – PMSM – VVVF control – open loop -V/f – self-control – rotor configuration field oriented control – surface mounted PM – constant torque – flux weakening – interior PM – MTPA – sensorless control – BLDC Motor – EMF – torque – VSI – half wave – full wave – speed control – torque ripple – sensorless control – Switched Reluctance Motor – principle – operation modes – converter control – Axial Flux Machine – principle and operation.

Textbooks/References

1. Bimal K. Bose, “Power Electronics and Variable Frequency Drives”, Wiley IEEE Press, 2010.
2. Krishnan R, “Electric Motor Drives Modeling, Analysis and Control”, Pearson, 2015.
3. G.K Dubey, “Fundamentals of Electric Drives”, Narosa Publishing House, 2010
4. De Doncker, Rik, Pulle, Duco W J, Veltman, Andre, “Advanced Electrical Drives – Analysis, Modeling, Control”, Springer, 2011.

25PE635	Power Components and Electromagnetic Compatibility	L-T-P-C: 2-0-3-3

Pre-requisite: Nil

Course Objective

- To design magnetic and thermal components for power converters using datasheets and thermal analysis.
- To develop and validate power converter layouts with EMI/EMC and simulation tools.

Course Outcomes

CO1: Design magnetic components, including inductors, gate-driver transformers, and snubbers for power converters
CO2: Evaluate inverter losses and cooling requirements using IGBT datasheets and thermal system design
CO3: Develop PCB layouts with EMI/EMC considerations using ECAD tools like KiCad, Altium, and Saturn
CO4: Analyse power converter behaviour and validate designs using simulation tools such as Ansys

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4/PSO1	PO5/PSO2
CO1	2	1	3	2	-
CO2	2	1	3	2	-
CO3	2	1	2	2	-
CO4	2	1	2	2	2

Syllabus

Magnetics – Magnetic design – Inductor – Gate driver transformer – Cooling system – Switching losses – Conduction losses – IGBT datasheet – Inverter power loss – Inverter efficiency – Cooling system design - Snubbers & DC Link Capacitor – Snubber theory – Snubber topologies – Snubber calculation – DC link capacitor - PCB Design – Datasheet – Schematic symbol – PCB footprint – Layout – Polygon pour – Thermal relief – EMI/EMC – High speed routing – Double sided PCB – PCB penalization – Gerber file - EMI/EMC – EMI types – Measurement – Standards – ESD – High frequency behavior – Susceptibility – Noise suppression – EMI reduction – Grounding – Shielding – Bonding – Cables – Connectors – EMI filters – EMC test equipment.

Textbooks/References

1. W.G. Hurley, W.H. Wolfle, “Transformers and Inductors for Power Electronics”, John Wiley & Sons Publication Ltd.,2013.
2. Peter Dalmaris, “KiCad Like a Pro”, Tech Explorations,4th edition, 2024.
3.https://www.altium.com/in/education

4. Nicolas Patin, “Power Electronics Applied to Industrial Systems and Transports – Volume-4, Electromagnetic Compatibility”, ISTE Press Ltd and Elsevier Ltd, 2015.
5. François Costa, Cyrille Gautier, Eric Labouré, Bertrand Revol, “Electromagnetic Compatibility in Power Electronics”, ISTE Ltd and John Wiley & Sons, Inc., 2014.

25PE636 Power Electronics for Renewable Energy and Microgrid Systems L-T-P-C: 2-0-3-3

Pre-requisite: Design &Analysis of Power Converters

Course Objective

- To understand solar, wind, hybrid renewable energy systems, energy storage systems
- To apply modern power electronics & control systems for integration of renewable energy generation and energy storage

Course Outcomes

CO1: Understand the principles, types, modeling, and configurations of PV and wind energy systems.
CO2: Design and analyze renewable energy systems using MPPT algorithms and power electronic converters.
CO3: Evaluate energy storage technologies, battery sizing, bidirectional converters, and V2G strategies.
CO4: Assess microgrid topologies, control methods, and renewable energy integration policies.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4/PSO1	PO5/PSO2
CO1	2	1	2	2	-
CO2	2	1	2	2	-
CO3	2	3	2	2	1
CO4	2	3	2	2	1

Syllabus

Solar and Wind Energy Systems – PV cell: working principle, types, construction – PV modeling – MPPT techniques – PV configurations: stand-alone and grid-connected – Design considerations.
Wind Energy Generators (WEG): small turbines, grid-connected systems – Hybrid configurations: wind-solar, wind-PV-hydro – Stand-alone systems with storage – Battery sizing and energy management strategies - Power Electronics for Renewable Systems – Converters for PV: grid-tied, grid-forming, active power control – Wind turbine converters: PMSG, DFIG, dual converters with DC-link – Rotor/grid-side control – MPPT, filter design, synchronization, phase-locking
Energy Storage Technologies – Need for storage in RE systems – Types: pumped hydro, batteries, supercapacitors – Dynamic control, variable speed operation – Power electronic interfaces for storage systems – Electric vehicle batteries as mobile storage - Bidirectional converters for battery integration and vehicle-to-grid (V2G) systems – Charging/discharging control strategies – On-board and off-board chargers – Grid impact and stability.
Microgrids and Integration – AC, DC, and hybrid topologies – Islanded and grid-connected modes – Storage and V2G integration – Converter control: DC-DC, inverters, PLL, voltage/current control – Frequency stability, reactive power compensation, active filtering – Microgrid control strategies: centralized, decentralized, hierarchical.

Textbooks/References

1. *Solanki, C. S., "Solar photovoltaics: fundamentals, technologies and applications". PHI Learning Pvt. Ltd.,2015.*
2. *Tiwari G. N., "Solar Energy: Fundamentals, Design, Modeling and Applications", Narosa,2002.*
3. *Huggins R. A., "Energy Storage: Fundamentals, Materials and Applications", Springer,2015.*
4. *Magdi S Mahmoud, "Microgrid: Advanced Control Methods and Renewable Energy System Integration", Butterworth-Heinemann, 2016*
5. *Haitham Abu-Rub, Mariusz Malinowski, Kamal Al-Haddad, "Power Electronics for Renewable Energy Systems, Transportation and Industrial Applications", Wiley Publishers, June 2014.*
6. *S N Bhadra, D Kastha and S Banerji, "Wind Electrical Systems", Oxford University Press,2005.*
7. *S. M. Sharkh, M. A. Abu-Sara, G. I. Orfanoudakis and B. Hussain, "Power Electronic Converters for Microgrids," Wiley – IEEE Press,2014.*

25PE637	Condition Monitoring and Predictive Maintenance	L-T-P-C: 2-0-3-3

Pre-requisite: Nil

Course Objective

- To impart knowledge on condition monitoring of electrical machines through theoretical and practical approach using finite element analysis, signal processing and artificial intelligence.

Course Outcomes

CO1: Understand the occurrence of various faults and their causes in electrical machines.
CO2: Modelling of faults in electrical machines.
CO3: Analyze the faults using finite element and various signal-processing approaches.
CO4: Apply artificial intelligence techniques for fault diagnosis.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4/PSO1	PO5/PSO2
CO1	3	-	3	-	-
CO2	3	-	3	2	-
CO3	3	-	2	2	2
CO4	3	-	2	2	2

Syllabus

Principles of variable speed drives applied to electrical machines – Reliability of Machines and typical failure rates - Need for Condition Monitoring – Methodologies. Faults in induction and synchronous machines – stator, rotor, bearing, eccentricity, demagnetization. Modeling of electrical machines – winding function approach, magnetic equivalent circuit method.

Analysis of faults using finite element method – geometric modelling, analysis of airgap flux density, Fault diagnosis techniques based on frequency domain – vibration, current, power and flux, Fault diagnosis techniques based on model-based techniques.

Application of pattern recognition to fault diagnosis, Digital signal processing requirements for fault diagnosis, Application of artificial intelligence techniques for fault diagnosis.

Textbooks/References

1. Toliyat, Hamid A., et al. Electric machines: modeling, condition monitoring, and fault diagnosis. CRC press, 2012.

2. Tavner, Peter, et al. Condition monitoring of rotating electrical machines. 3rd Edition. IET, 2020

SPECIALIZATION ELECTIVE: Electric Vehicle Technology

25EV641	System Engineering for Electric Vehicle	L-T-P-C: 2-0-3-3

Pre-requisite: Nil

Course Objective

- To provide a comprehensive understanding of electric vehicle architecture
- To develop model-based development techniques for EV systems

Course Outcomes

CO1: To understand components, and performance characteristics of electric and hybrid electric vehicles

CO2: Analyze traction motor characteristics, tractive effort, and transmission requirements for electric vehicle propulsion

CO3: Evaluate hybrid electric drive train architectures

CO4: Perform validation and testing using simulation tools including MIL, SIL, HIL

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4/PSO1	PO5/PSO2
CO1	2	-	3	3	-
CO2	2	-	2	3	-
CO3	2	-	3	3	-
CO4	2	1	2	3	2

Syllabus

Introduction to Electric Vehicles, Benefits and limitations of EV as compared with IC Engine-based Vehicles. EV Components, Basic design concepts, Performance of Electric Vehicles, Traction motor characteristics, Tractive effort and Transmission requirement, xEV Drive Trains:- Architecture of Hybrid Electric Drive Trains, Series Hybrid Electric Drive Trains, Parallel hybrid electric drive trains.

Model-Based Development - automotive - requirements - configuration - data dictionary - signals – parameters -EV Modeling - motor (AC, DC) - battery - thermal management - converters - performance - drive cycles - tractive power - resistance - torque - coordinate system - wheels - tires - slip angle – dynamics - Validation & Testing - simulation - advisor - code generation – MIL – SIL – PIL – HIL – testing.

Textbooks/References

1. Shuvra Das, “Modeling for Hybrid and Electric Vehicles Using Simscape” (Synthesis Lectures on Advances in Automotive Technology), Morgan & Claypool Publishers (2021)

2. Saurabh Mani Tripathi, Francisco M, Gonzalez,”Real Time Simulation and Hardware-in-the loop Testing using Typhoon HIL, Springer,2023.

3. H.S. Lahman, “Model Based Development Applications”, Addison-Wesley Publications, 2021.

4. James Larminie, John Lowry, Electric Vehicle Technology Explained, 2nd Edition, John Wiley and Sons, 2012.

5. John G. Hayes, G. Abas Goodarzi, Electric Powertrain Energy Systems, Power Electronics and Drives for Hybrid, Electric and Fuel Cell Vehicles, John Wiley and Sons, 2018.

25EV642	Vehicle Dynamics & Stability	L-T-P-C: 3-0-0-3

Pre-requisite: Nil

Course Objective

- To understand dynamic models of vehicle systems and evaluate their performance characteristics under various driving conditions.
- To simulate vehicle motion and interpret the vehicle response through modeling tools and experimental validation techniques.

Course Outcomes

CO1: Analyse and formulate the dynamic models for vehicle systems

CO2: Evaluate the performance characteristics of vehicle dynamics under various driving conditions

CO3: Demonstrate the vehicle motion and analyze the vehicle response for various driving conditions

CO4: Simulate various driving conditions and experimental validation

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4/PSO1	PO5/PSO2
CO1	2	-	3	3	-
CO2	2	-	3	2	-
CO3	2	-	3	2	1
CO4	2	2	3	3	-

Syllabus

Introduction to vehicle dynamics - Coordinate systems - dynamic analysis - forces on vehicle - traction - braking - aerodynamic resistance - longitudinal dynamics - acceleration performance - gradeability - driveline modeling (ICE - HEV - EV) - tire-road interaction - slip ratio - lateral dynamics - steering - suspension kinematics - bicycle model - understeer - oversteer - neutral steer - vehicle handling - vertical dynamics - ride comfort - road input modeling - quarter-car model - half-car model - full-car model - ride quality metrics - tire modeling - slip angle - lateral forces - longitudinal forces - rolling resistance - vehicle stability - yaw dynamics - rollover stability - load transfer - stability derivatives - state-space modeling - active safety systems - simulation studies.

Textbooks/References

1. Thomas Gillespie, “Fundamentals of Vehicle Dynamics”, SAE International Publication, 2017.
2. Popp, Karl, Schiehlen and Werner, “Ground Vehicle Dynamics”, Springer Publication, 2020
3. Rao Dukkipati and Jian Pang, “Road Vehicle Dynamics”, SAE International Publication, 2008.
4. Richard Barnard, “Road Vehicle Aerodynamic Design”, Second Revised Edition, Mechaero Publishing, 2021
5. Rajesh Rajamani, “Vehicle Dynamics and Control”,Second Edition, Springer,2012.

25EV643	Vehicular Electronics & Driver Assistance Systems	L-T-P-C: 3-0-0-3

Pre-requisite: Nil

Course Objective

- To understand electronic systems, E/E architectures, topologies, networking, and simulators used in connected and autonomous vehicles.

- To analyze and implement ADAS functions using sensors, control models, perception systems, planning algorithms, and safety regulations.

Course Outcomes

CO1: Explain automotive electronic systems, E/E architectures, and communication topologies.
CO2: Analyze connected vehicle systems, simulators, and autonomous networking.
CO3: Design and evaluate ADAS features using control models, hardware, and software stacks.
CO4: Apply sensor technologies, perception algorithms, and global safety standards in intelligent vehicle systems.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4/PSO1	PO5/PSO2
CO1	2	-	2	3	-
CO2	1	-	3	2	-
CO3	2	1	3	2	-
CO4	1	1	2	3	1

Syllabus

Electronic Systems in Automotives, Introduction to E/E Architecture, Connected cars, Types of E/E architectures: Flat Architecture, Domain Architecture, Zonal Architecture: Topologies, Networking and Simulators used for Autonomous Vehicles,

ADAS - features - safety assessment - design considerations - hardware - software stack - vehicle modeling - control - adaptive cruise - adaptive headlights - ABS - parking assist - emergency braking - blind spot monitoring - electronic stability - collision warning - lane keeping - ISO 26262 - camera model - calibration - monocular vision - stereo vision - object detection - motion planning - scenarios - constraints - occupancy grid - LIDAR - HD maps - shortest path - motion prediction - time to collision - UNECE - GSR - Indian regulations.

Textbooks/References

1. Lipson, H & Kurman, M, Driverless: Intelligent Cars on the Road Ahead, MIT Press, 2020.
2. Dan Simon, “Optimal State Estimation: Kalman, H∞, and Nonlinear Approaches”, John Wiley & Sons, 2012.
3. Lawrence A. Klein, “Sensor and Data Fusion – A Tool for Information Assessment and Decision Making”, Second Edition, SPIE Press, USA,2012.
4. Ian Goodfellow, Yoshua Bengio, Aaron Courville, “Deep Learning”, MIT Press, 2016.
5. David Forsyth, Jean Ponce, “Computer Vision: A Modern Approach”, Pearson, 2023.
6. Yan Li and Hualiang Shi (Eds.), Advanced Driver Assistance Systems and Autonomous Vehicles: From Fundamentals to Applications, Springer Nature Singapore, 2022.
7. Thomas Königseder and Kirsten Matheus, Automotive Ethernet, 3rd Edition, Cambridge University Press, 2021.
8. William Ribbens, “Understanding Automotive Electronics: An Engineering Perspective”, 7th Edition, Butterworth-Heinemann, 2012.
9. H. Winner et al. (Eds.), Handbook of Driver Assistance Systems, Springer Cham, 2016.
10. Luca Venturi and Krishtof Korda, Hands-on Vision and Behavior for Self-Driving Cars, Packt Publishing Limited, 2020.

25EV644	Automotive System and Layered Architecture	L-T-P-C: 2-0-3-3

Pre-requisite: Nil

Course Objective

- To become acquaint with the framework for the development of automotive products.

Course Outcomes

CO1: Understand the Automotive domain, networking, communication protocols, and embedded systems. [Vehicle/System Level]

CO2: Understand the AUTOSAR Framework. [Software focus]

CO3: Understand the AUTOSAR Toolchain and implement an application/ generate an interface/ automate a system. [CAPL scripting (Automation)/ Tool for port generation/ Application or Diagnostics] AR text

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4/PSO1	PO5/PSO2
CO1	2	-	2	1	-
CO2	2	-	2	1	-
CO3	2	1	2	2	1

Syllabus

Introduction to the Automotive world: Automotive players- OEMs- Tier1, Tier2, Tier 3. Vehicle Architecture: Evolution of Vehicle Architecture, Domain and Zonal Architecture, introduction to communication protocols. Communication protocols- CAN, LIN, Ethernet, Automotive Embedded Systems: ECUs- MCUs, Automotive Applications, and Case studies

Layered software architecture [OSI reference model(optional)], Introduction to Automotive operating system – OSEK/VDX, Introduction to AUTOSAR- Evolution: Need/Purpose (problems with non-AUTOSAR systems approach), Classic and Adaptive AUTOSAR Overview, Classic AUTOSAR deep-dive: Overview of layers [ASW, RTE, BSW, CDD] with functional examples.

Brief intro about MBSE, System Composer, Case Studies – [AUTOSAR related exercise/projects using ARTOP, MBD]

Automotive toolchain: Network analysers: CAN, LIN, Ethernet (Ex: vector Canoe, Canalyser), IDE (Integrated Development Environment), AUTOSAR Authoring tools [AUTOSAR Builder, Simulink], BSW configuration tools [Vector, EB,], Software Development Life Cycle [SDLC- V model (Automotive SPICE introduction)], Introduction-Function Safety [ISO26262], Cybersecurity [ISO21434] (Optional)Highlights on trends: V2x and Connectivity, OTA, SDVs, Autonomous vehicles [connected to adaptive AUTOSAR]

Textbooks/References

1. https://www.autosar.org/standards/classic-platform
2. https://www.autosar.org/fileadmin/standards/R4-3/CP/AUTOSAR_EXP_LayeredSoftwareArchitecture.pdf
3.https://www.autosar.org/fileadmin/user_upload/AUTOSAR_Introduction_PDF/AUTOSAR_EXP_Introduction_Part1.pdfhttps://www.autosar.org/fileadmin/user_upload/AUTOSAR_Introduction_PDF/AUTOSAR_EXP_Introduction_Part2.pdf
4. https://www.autosar.org/standards/adaptive-platform
5. https://www.automotivespice.com/fileadmin/software-download/Automotive_SPICE_PAM_30.pdf

6. https://www.continental-automotive.com/en-gl/Passenger-Cars/Technology-Trends/software-defined-vehicles
7. Hossam Soffar, AUTOSAR Fundamentals and Applications: Establishing a solid foundation for automotive software design with AUTOSAR, Packt Books, Dec 2024.

25ES637	Embedded Systems for Automotive Applications	L-T-P-C: 2-0-3-3

Pre-requisite: Nil

Course Objectives

- To provide a comprehensive understanding of automotive fundamentals, functional domains, electrical subsystems.
- To introduce key electronic systems in modern vehicles, including powertrain control, chassis control, body electronics, safety systems, HVAC, hybrid vehicles, and emerging technologies like drive-by-wire and autonomous vehicles.
- To impart knowledge on automotive communication protocols such as CAN, LIN, Flex-Ray, MOST, and standards like AUTOSAR and OSEK VDX.

Course Outcomes

CO1: Understand various automotive subsystems

CO2: Introduce Automotive sensors and actuators

CO3: Develop automotive control systems in embedded platform.

CO4: Understand various automotive communication protocols and software architecture

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4/PSO1	PO5/PSO2
CO1	1			1	1
CO2	1		1	1	1
CO3	2	1	2	2	2
CO4	2	1	2	1	1

Syllabus

Automotive Fundamentals – Vehicle functional domains and requirements – Automotive Electrical subsystems- The systems approach to control and automotive instrumentation – Sensors and Actuators in various vehicle domains. Systems in Power Train Electronics: Engine Management Systems in Chassis control: ABS, ESP,TCS, Active Suspension Systems, Cruise Control and Adaptive Cruise control systems – Body Electronic systems – Automotive Safety systems HVAC – Electric Hybrid Vehicles and their configurations- Drive-by-wire systems – Autonomous and Connected Vehicles and their challenges-Introduction to Embedded Automotive Protocols: CAN, LIN, Flex-Ray, MOST-AUTOSAR standard and its applications - OSEK VDX Open Systems in Automotive Networks.

Textbooks/References

1. William B. Ribbens, *"Understanding Automotive Electronics – An Engineering Perspective"*, Eight Edition, Elsevier Inc., 2017.
2. Robert Bosch GmbH, *"Bosch Automotive Electrics and Automotive Electronics -Systems and Components, Networking and Hybrid Drive"*, Fifth Edition, Springer Vieweg, 2007.
3. Najamuz Zaman, *"Automotive Electronics Design Fundamentals"*, Springer, 2015.
4. V. A. W. Hillier and David R. Rogers, "Hillier's Fundamentals of Motor Vehicle Technology on Chassis and Body Electronics", Fifth Edition, Nelson Thrones, 2007.
5. Tom Denton, *"Automobile Electrical and Electronic Systems"*, Fifth edition, Routledge, 2017.

25EV645	Battery Management and Charging Systems	L-T-P-C: 2-0-3-3

Pre-requisite: Nil

Course Objective

- To familiarise with the battery systems and battery management, charging/discharging principles, cell balancing, and parameter estimation.
- To design and implement battery models for real-time applications in electric and hybrid electric vehicles

Course Outcomes

CO1: Understand the principle of the battery and battery management system.
CO2: Interpret the concept associated with the battery charging/discharging process.
CO3: Familiarize with various cell balancing techniques and parameter estimation.
CO4: Design a battery model for real-time applications.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4/PSO1	PO5/PSO2
CO1	2	-	2	-	-
CO2	2	-	3	-	-
CO3	2	-	3	1	-
CO4	2	1	2	2	1

Syllabus

Batteries – working principle – primary-secondary – performance evaluation – nominal voltage – capacity – C-rate – energy – power – series-parallel – lithium-ion – equivalent circuit – physics based – empirical model – emerging technologies - BMS – functionality – pack topology – voltage sensing – current sensing – temperature sensing – contactor control – isolation sensing – thermal control – protection – communication – range – BMS processors, SoC, SoH and power estimation – model based estimation – Kalman Filter, Machine learning approaches – and power estimation model based estimation – health estimation – aging – cell balancing – imbalance – balancing circuits – cooling - Charging – rechargeable – charging modes – overcharge – undercharge – standards – CHAdeMO – GB/T – ISO-15118 – discharge models – drive cycles – auxiliary loads – onboard charger – offboard charger – OCPP - Case study– battery pack – battery life – energy balancing – multi battery system. Case studies from Mathworks.

Textbooks / References

1. Pistoia, Gianfranco, and Boryann Liaw, "Behaviour of Lithium-Ion Batteries in Electric Vehicles: Battery Health, Performance, Safety, and Cost", Springer International Publishing AG, 2018.
2. Plett, Gregory L., "Battery management systems, Volume I: Battery modeling", Artech House, 2015.
3. Bergveld, H.J., Kruijt, W.S., Notten, P.H.L., "Battery Management Systems -Design by Modelling", Philips Research Book Series 2002.
4. Davide Andrea," Battery Management Systems for Large Lithium-ion Battery Packs", Artech House, 2010.
5. Pop, Valer, et al., "Battery management systems: Accurate state-of-charge indication for battery-powered applications", Vol. 9, Springer Science & Business Media, 2008.

25EV646	ADAS and Autosar	L-T-P-C: 2-0-3-3

Pre-requisite: Nil

Course Objective

- This course empowers learners with advanced insights into AUTOSAR-based automotive software architectures and intelligent ADAS frameworks, integrating embedded systems, high-performance computing, and AI-driven perception for next-generation mobility solutions

Course Outcomes

CO1: Understand the layered software architecture of AUTOSAR and its role in embedded automotive systems.
CO2: Apply and configure Classic and Adaptive AUTOSAR modules for real-world ECU functions.
CO3: Analyze ADAS system architecture and implement AI-based perception algorithms.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4/PSO1	PO5/PSO2
CO1	3		3	3	2
CO2	3		3	2	3
CO3	3		3	3	2

Syllabus

Fundamentals of Classic AUTOSAR and Automotive Software Design

Basics of Automotive Electronics and ECUs: Introduction to Embedded Systems in Automobiles, Overview of the AUTOSAR Consortium and Standardization, AUTOSAR Classic Platform: Architecture Layers (MCAL, BSW, RTE, SWC), Communication Protocols: CAN, LIN, Ethernet – Fundamentals and Uses, AUTOSAR Development Workflow and System Configuration (ARXML), Introduction to AUTOSAR Tools: Vector and EB tresos, Model-Based Design with Simulink and Code Generation Basics, Software Component Design and Port Mapping in Simulink, **Case Study**:

Fundamentals of Adaptive AUTOSAR and High-Performance Vehicle Computing

Differences between Classic and Adaptive AUTOSAR, Need for Adaptive AUTOSAR in Autonomous and Connected Vehicles, Introduction to POSIX-based Operating Systems (Linux, QNX), Overview of Adaptive AUTOSAR Execution Environment, Service-Oriented Architecture Basics: SOME/IP and DDS Fundamentals, Application Manifest, Service Discovery, Execution Management, Introduction to Cybersecurity and Functional Safety in Adaptive Platforms, Tools for Adaptive AUTOSAR: AUTOSAR Builder, Eclipse IDE, Over-the-Air (OTA) Update Concepts and Diagnostics, **Case Study**:

Fundamentals of ADAS and AI Applications in Vehicle Systems

Overview of ADAS: Objectives, Passive and Active Safety Systems, Basic ADAS Features: Cruise Control, Lane Departure, Blind Spot Detection, Sensors in ADAS: Working Principles of Radar, Camera, LiDAR, Ultrasonic, Introduction to AI in ADAS: Object Detection using CNNs, Lane Detection using Image Processing, Pedestrian Detection using Pre-trained Models, Reinforcement Learning Basics for Path Planning, Driver Monitoring Systems: Camera-based Eye Tracking and Drowsiness Detection, Simulation Tools: MATLAB ADAS Toolbox, Python OpenCV, **Case Study**.

Textbooks/References

1. https://www.autosar.org/standards/classic-platform
2. https://www.autosar.org/standards/adaptive-platform
3. https://www.autosar.org/fileadmin/standards/R4-3/CP/AUTOSAR_EXP_LayeredSoftwareArchitecture.pdf
4. ISO 26262: Functional Safety for Road Vehicles

5. ISO/SAE 21434: Cybersecurity Standard for Road Vehicles
6. https://www.automotivespice.com/
7. MathWorks ADAS Toolbox, Simulink, and Deep Learning Toolbox
8. Python OpenCV for Perception Algorithms in ADAS
9. Continental Automotive Training Resources on Software-Defined Vehicles
10. Hossam Soffar, AUTOSAR Fundamentals and Applications: Establishing a solid foundation for automotive software design with AUTOSAR, Packt Books, Dec 2024.
11. Yan Li and Hualiang Shi (Eds.), Advanced Driver Assistance Systems and Autonomous Vehicles: From Fundamentals to Applications, Springer Nature Singapore, 2022.

SPECIALIZATION ELECTIVE: AI and IoT

25AI651	IoT and System Design	L-T-P-C: 2-0-3-3

Pre-requisite: Nil

Course Objectives

- To equip students with the knowledge of modern IoT architectures, including fog and edge computing, and their applications in industrial domains.
- To enable students to design and implement secure embedded IoT systems using various sensors, actuators, and communication protocols.
- To develop the ability to integrate real-time data with cloud and edge platforms for effective monitoring, control, and visualization in smart environments.

Course Outcomes

CO1: Understand IoT architectures, various communication technologies, and industry standards.
CO2: Design a suitable IoT-enabled system with sensors, actuators, and communication protocols.
CO3: Develop secure IoT systems using appropriate communication and encryption techniques.
CO4: Implement real-time data acquisition and visualization using cloud, fog, and edge computing techniques.
CO5: Demonstrate IoT modules for Industry 4.0 scenarios and smart city applications.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4/PSO1	PO5/PSO2
CO1	2	-	-	-	-
CO2	2	-	1	2	-
CO3	3	2	2	3	3
CO4	3	2	3	3	3
CO5	3	3	3	3	3

Syllabus

Introduction to IoT: Concepts, Evolution, and Key Features, IoT Architectural Models: 3-layer, 5-layer, Service-Oriented Architecture (SOA). End, Edge and Fog Computing, Cloud Computing – platforms, IoT system design process.

Embedded Systems in IoT: Microcontrollers and SBCs Overview (ESP32, Raspberry Pi). Peripheral Interfaces: GPIO and ADC Basics, I2C and SPI Communication Protocols, UART Communication. Data Representation formats. Embedded IoT Programming Environments: Arduino IDE, Embedded C/C++, Python.

Communication Technologies and Protocols: ZigBee, LoRa, NB-IoT, Wi-Fi, BLE. IEEE and Industry Standards: 802.15.4, 802.11. IoT Communication Protocols: Industrial Protocols Overview – CAN, Modbus TCP/IP. MQTT, CoAP, HTTP(S), REST APIs. IoT Security Fundamentals: TLS/SSL, Secure Boot, OTA Updates. Securing IoT Communication. UI Development for IoT. Industrial IoT and Industry 4.0: Concepts, Components, and Use Cases, Smart Grid/City Applications.

Textbooks/References

1. *Sudip Misra, Anandarup Mukherjee, Arijit Roy, Introduction to IoT, Cambridge University Press, 1st Edition, 2021.*
2. *Sudip Misra, Chandana Roy, Anandarup Mukherjee, Introduction to Industrial Internet of Things and Industry 4.0, CRC Press, 1st Edition, 2020.*
3. *Rajkumar Buyya, Satish Narayana Srirama, Fog and Edge Computing: Principles and Paradigms, Wiley, 1st Edition, 2019.*
4. *Shriram K Vasudevan, Abhishek S Nagarajan, RMD Sundaram, Internet of Things, John Wiley & Sons, 1st Edition, 2019.*

25AI652	Deep Learning	L-T-P-C: 2-0-3-3

Pre-requisite: Nil

Course Objectives

- To impart foundational knowledge of deep learning architectures, data preprocessing, and model optimization techniques applicable to electrical engineering problems.
- To enable students to design, implement, and evaluate CNN and RNN-based models for real-world applications.

Course Outcomes

CO1: Understand the core concepts of AI, ML, and DL along with key neural network components.
CO2: Design and evaluate deep neural networks using various optimization strategies and regularization techniques to improve training performance and generalization.
CO3: Implement convolutional neural networks (CNNs) for visual and signal-based tasks, and utilize transfer learning and model interpretability methods.
CO4: Develop sequence models using RNN, LSTM, and GRU architectures for time-series forecasting and event detection in real life problems.
CO5: Explore and apply advanced architectures such as GANs and Transformers for complex generative and attention-based modeling tasks.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4/PSO1	PO5/PSO2
CO1	3	-	3	3	1
CO2	3	-	3	3	2
CO3	3	-	3	3	2
CO4	3	-	3	3	2
CO5	3	-	3	3	2

Syllabus

Overview of AI, ML, and DL, Multi-layer perceptrons, Activation functions (ReLU, Sigmoid, Tanh), Loss functions and cost, Performance analysis of Classifier and Regression model. Essential Data Pre-processing for Deep Learning.

Backpropagation and gradient descent, Stochastic Gradient Descent (SGD), RMSProp, Adam. Weight initialization. Overfitting and underfitting. Regularization techniques: regularization, dropout, Batch normalization. Deep Neural Networks.

Convolution layers, pooling layers, CNN architectures. 1D CNNs for signal processing, Transfer learning and fine-tuning pre-trained models, Visualization techniques: saliency maps, Grad-CAM for explaining CNN decisions, Application of CNN.
Comparison between static and sequential data, Sequence modeling, RNN architecture, Limitations of RNNs: vanishing/exploding gradients, short memory retention, Internal structure of LSTM, Gated Recurrent Unit (GRU) Networks, Comparison in terms of performance and complexity, Advanced architectures: GAN, Transformers.

Textbooks/References

1. *Goodfellow, Y, Bengio, A. Courville, "Deep Learning", MIT Press, 2016.*
2. *S. Haykin, "Neural Networks and Learning Machines", 3rd Edition, Pearson, 2008*
3. *Aditi Majumder, M. Gopi, Introduction to Visual Computing: Core Concepts in Computer Vision, Graphics, and Image Processing, CRC Press; 1 edition, 2018*
4. *Francois Chollet, "Deep Learning with Python", 2nd Edition, Manning Publications, 2021.*

25AI653	**Intelligent Control**	**L-T-P-C: 2-0-3-3**

Pre-requisite: Nil

Course Objectives

- To understand the principles and applications of intelligent control systems.
- To familiarize students with soft computing techniques such as fuzzy logic, neural networks, and evolutionary algorithms.

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Course Outcomes

CO1: Understand the foundational concepts and evolution of intelligent control systems.
CO2: Comprehend soft computing techniques and their application in control systems.
CO3: Analyze advanced techniques used in intelligent control mechanism.
CO4: Apply intelligent control strategies to real-world problems in IoT and edge computing.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4/PSO1	PO5/PSO2
CO1	3	-	-	-	-
CO2	2	2	2	2	1
CO3	1	2	2	2	-
CO4	2	-	-	-	1

Syllabus

Foundations of Intelligent Control Systems: Basic understanding of control systems. Evolution of intelligent control in engineering applications. Definition and scope of intelligent control. Comparison between intelligent control and classical control systems. Smart control technologies in automation, robotics, and IoT. Present developments and international policies in intelligent control. Overview of stakeholders in intelligent control systems.
Features of intelligent control – Fuzzy Logic Systems (FLS), Neural Networks (NN), Evolutionary Algorithms (EA). Hybrid systems – Neuro-Fuzzy Systems, GA-NN integration. Sensors and devices – Intelligent Electronics Devices (IED), IoT-enabled controllers. Communication standards and protocols for intelligent systems.
Advanced Techniques in Intelligent Control: Reinforcement Learning (RL) – Markov Decision Processes (MDP), Q-Learning, Deep Q-Networks (DQN). Adaptive and Predictive Control – Model Predictive Control (MPC), Self-

tuning controllers. Edge AI and embedded systems – Implementation of intelligent control on microcontrollers (e.g., Raspberry Pi, ESP32). Cyber-Physical Systems (CPS) – Role of intelligent control in CPS, security, and robustness. Applications and Future Trends in Intelligent Control: Industrial applications – Smart manufacturing, Industry 4.0, drones, autonomous vehicles, and robotics. Energy management systems. Emerging technologies – Quantum-inspired intelligent control.

Textbooks/References

1. *Nazmul Siddique, "Intelligent Control: A Hybrid Approach Based on Fuzzy Logic, Neural Networks, and Genetic Algorithms", Springer, 2020.*
2. *Richard S. Sutton, Andrew G. Barto, "Reinforcement Learning: An Introduction", MIT Press, 2018.*
3. *Charu C. Aggarwal, "Neural Networks and Deep Learning: A Textbook", Springer, 2018.*
4. *Timothy J. Ross, "Fuzzy Logic with Engineering Applications", Wiley, 2019.*
5. *James B. Rawlings, David Q. Mayne, Moritz Diehl, "Model Predictive Control: Theory, Computation, and Design", Nob Hill Publishing, 2017.*
6. *Xiaofei Wang, Yiwen Han, Victor C. M. Leung, Dusit Niyato, Xueqiang Yan, Xu Chen "Edge AI: Convergence of Edge Computing and Artificial Intelligence", Springer, 2021.*

25AI654	Cyber Systems and Security	L-T-P-C: 3-0-0-3

Pre-requisite: Nil.

Course Objectives:

- To understand and evaluate security challenges in cyber-physical systems (CPS) and electrical infrastructures, including smart grids and IoT-enabled networks.
- To apply standards, secure protocols, and cryptographic techniques to protect systems in the Electrical and Electronics domains.

Course Outcomes:

CO1: Understand cyber threats and vulnerabilities in electrical and industrial cyber-physical systems.
CO2: Comprehend various standards and best practices towards the design of secure electrical automation systems.
CO3: Implement secure communication protocols and access control in various electrical applications.
CO4: Develop cryptographic and machine learning-based techniques for intrusion detection and threat mitigation in smart energy environments.

CO-PO Mapping:

PO/PSO / CO	PO1	PO2	PO3	PO4/PSO1	PO5/PSO2
CO1	3	-	-	-	-
CO2	2	-	-	-	-
CO3	3	2	1	-	2
CO4	2	1	-	1	2

Syllabus

Introduction - Overview of computer networks, network security, and Application layer. Overview of HTTP, FTP, SMTP, and DNS, and socket programming. Hijacking, spoofing, and DoS attacks. Firewalls, Intrusion Detection Systems (IDS), and Intrusion Prevention Systems (IPS). Digital Forensics. Transport layer and UDP, TCP. UDP flooding, TCP spoofing, TCP connection hijacking, TCP SYN flood. Cryptography and System Hardening: Public

key infrastructure (PKI), symmetric and asymmetric cryptography, key management systems, ECC and AES integration for CPS security. Secure boot, firmware signing, and Over-The-Air (OTA) update mechanisms for edge and embedded devices. Network layer – Addressing schemes (IPv4 and IPv6), Routing algorithms, Routing protocols in the Internet (OSPF, RIP, and BGP), BGP security, ICMP, NAT, IPSec, and IPSec Authentication. Header, Encapsulating Security Header and Payload, IPSec Key Exchange, and VPNs. Link layer - Introduction and services, Link layer addressing, Multiple Access Protocols, Ethernet, ARP, Attacks against, and vulnerabilities in ARP. Secure Software Development Life Cycle (SSDLC). Industrial Communication Protocols and Security Considerations: DNP3 (with Secure Authentication), Modbus (with Modbus Secure/TLS), IEC 61850 (with IEC 62351 extensions), and OPC-UA. Role-Based Access Control (RBAC) in Automation Systems. ISA/IEC 62443 Standard Compliance. Control System Security: ISA/IEC 62443, IEEE C37.240, and NIST SP 800-82 standards. Application of machine learning models for threat detection and behaviour profiling in electrical networks.

Textbooks/References

1. Arshad, M. (Ed.), "Cybersecurity Issues in Smart Grids and Future Power Systems", *MDPI*, 2023.
2. Wang, W., & Lu, C., "Power Systems Cybersecurity: Methods, Concepts, and Best Practices", *Springer*, 2023.
3. AccessEngineering, "Intrusion Detection Systems and Network Security", *McGraw-Hill*, 2021.
4. Gerardus Blokdyk, "Intrusion Detection: A Complete Guide – 2021 Edition", *The Art of Service*, 2021.
5. Mathur, A., "Modern Cryptography for Cybersecurity Professionals", *Packt Publishing*, 2021.
6. Rosulek, M., "The Joy of Cryptography", 1st Edition, 2021.
7. Van Oorschot, P. C., "Computer Security and the Internet: Tools and Jewels from Malware to Bitcoin", 2nd Edition, *Springer*, 2021.
8. IEEE Standard 1686-2023, "Standard for Cybersecurity Capabilities of Intelligent Electronic Devices", *IEEE*, 2023.
9. IEEE C37.240- 2021, "Cybersecurity Requirements for Substation Automation, Protection, and Control Systems", *IEEE*, 2021.

25AI655	Cloud Computing and Big Data Analytics	L-T-P-C: 3-0-0-3

Pre-requisite: Nil

Course Objectives

- To understand the key concepts and architecture of cloud computing platforms and services.
- To explore various cloud service models (IaaS, PaaS, SaaS) and deployment models (Public, Private, Hybrid).
- To study the frameworks and algorithms used in big data processing.
- To develop skills to design and implement scalable cloud-based big data analytics applications.

Course Outcomes

CO1: Understand the architecture and services of cloud computing models.
CO2: Equip knowledge on various cloud platforms like AWS, Azure, and Google Cloud.
CO3: Apply big data frameworks such as Hadoop and Spark for large-scale data processing.
CO4: Design cloud-based systems for scalable storage and analytics.
CO5: Explore challenges in cloud security, resource management, and big data integration.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4/PSO1	PO5/PSO2
CO1	3	2	-	-	-

CO2	3	-	-	3	2
CO3	3	1	2	3	2
CO4	3	-	-	2	1
CO5	3	1	-	-	1

Syllabus

Cloud computing overview: Definitions, benefits, and challenges - Service models: IaaS, PaaS, SaaS - Deployment models: Public, Private, Hybrid, Community - Virtualization: Hypervisors, VM management, Containers (Docker, Kubernetes) - Cloud storage systems: S3, Blob storage, HDFS- Case studies: AWS, Microsoft Azure, Google Cloud Platform

Big Data characteristics: Volume, Velocity, Variety, Veracity, Value - Hadoop Ecosystem: HDFS, MapReduce, YARN, Hive, Pig - Apache Spark: RDDs, DataFrames, MLlib, Streaming - NoSQL Databases: HBase, Cassandra, MongoDB - Data ingestion tools: Flume, Sqoop, Kafka - Hands-on Labs: Basic Hadoop and Spark jobs using sample datasets

Big Data analytics pipeline in the cloud - Data Lake architecture and storage options - Scalable machine learning in the cloud (ML on AWS, Azure ML, Google AI Platform) - Serverless computing and Lambda functions - Real-time analytics using Spark Streaming / Apache Flink - Security, privacy, and compliance in cloud-based big data systems - Case studies: Recommendation engines, IoT analytics, social media mining.

Textbooks/References

1. *Buyya, R., Vecchiola, C., & Selvi, S. T., "Mastering Cloud Computing: Foundations and Applications Programming", 1st Edition, McGraw-Hill Education, 2013.*
2. *White, T., "Hadoop: The Definitive Guide, 4th Edition, O'Reilly Media, 2015.*
3. *Zaharia, M., Wendell, P., Das, T., & Armbrust, M., "Learning Spark: Lightning-Fast Big Data Analysis", 1st Edition, O'Reilly Media, 2015.*
4. *Bahga, A., & Madisetti, V., "Cloud Computing: A Hands-On Approach", 1st Edition, Universities Press, 2014.*
5. *M Sudheep Elayidom, Sarith Divakar M, Lija Mohan, Tanmay Kumar Pandey, Shubham Agrawal, "Cloud Computing & Big Data: From the Basics to Practical Use Cases", 1st Edition, 2024.*
6. *Amazon Web Services (AWS) Documentation – Available at: https://docs.aws.amazon.com*
7. *Microsoft Azure Documentation – Available at: https://learn.microsoft.com/en-us/azure/*
8. *Google Cloud Documentation – Available at: https://cloud.google.com/docs*

25AI656	**AI-driven Renewable Energy**	**L-T-P-C: 3-0-0-3**

Pre-requisite: Nil

Course Objectives

- To understand the fundamentals of renewable energy systems and their integration with AI technologies.
- To apply AI techniques for smart grid operations, demand-side management, and energy storage optimization.
- To design intelligent solutions using IoT, edge computing, and digital twins for sustainable energy systems.

Course Outcomes

CO1: Understand the evolution and significance of AI in renewable energy systems.
CO2: Apply machine learning algorithms for energy forecasting and load management.
CO3: Design AI-based optimization strategies for hybrid renewable energy systems.
CO4: Implement AI-driven smart grid and IoT-based energy monitoring systems.
CO5: Analyze the environmental and performance impacts of AI deployment in energy systems.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4/PSO1	PO5/PSO2
CO1	2	-	-	-	-
CO2	3	-	2	2	2
CO3	3	2	2	2	2
CO4	3	2	2	2	2
CO5	2	-	1	-	1

Syllabus

Evolution of Renewable Energy Systems. Role of AI in Energy Forecasting, Optimization, and Control. Types of AI Techniques: Machine Learning, Deep Learning, Reinforcement Learning. Overview of Solar, Wind, Hydro, and Hybrid Renewable Energy Systems. Challenges in Integrating AI with Renewable Energy.

Time Series Forecasting Models: ARIMA, SARIMA, LSTM, GRU. Solar Power Forecasting Using AI. Wind Power Forecasting and Uncertainty Handling. Demand Forecasting and Load Management. Machine learning techniques in Wind/Solar Forecasting, Integration ML strategies techniques – Standalone Wind/Solar, Microgrid/EV for small/medium and industrial consumers, Reinforcement Learning for Energy Storage and Grid Integration.

AI in Smart Grids: Monitoring, Protection, and Control. Digital Twins for Renewable Energy Systems. Optimization Algorithms. AI-Based Fault Detection and Predictive Maintenance. Edge Computing and IoT for Intelligent Energy Management. Ethical and Environmental Considerations in AI Deployment.

Textbooks/References

1. *Ajay Kumar Vyas, S. Balamurugan, Kamal Kant Hiran, "Artificial Intelligence for Renewable Energy Systems", John Wiley & Sons, 2022.*
2. *Kwok Tai Chui, Miltiadis Lytras, "Artificial Intelligence for Smart and Sustainable Energy Systems and Applications", MDPI, February 2020.*
3. *Mustapha Hatti, "Renewable Energy for Smart and Sustainable Cities", Springer, 2018.*
4. *Ankush Ghosh, Rabindra Nath Shaw, Saad Mekhilef, Valentina Emilia Balas, "Applications of AI and IOT in Renewable Energy", Elsevier, 2022.*
5. *Jingzheng Ren, "Renewable-Energy-Driven Future", Academic Press, 2020.*
6. *Provas Kumar Roy, Sunanda Hazra, Chandan Paul, "Next-Generation Artificial Intelligence Driven Smart and Renewable Energy", CRC Press, July 2025.*

25AI657	**Smart Grid and Technologies**	**L-T-P-C: 3-0-0-3**

Pre-requisite: Nil

Course Objectives

- To equip with the significance and requirements of the smart grid
- To familiarize with communication technologies and real-time monitoring schemes
- To design smart solutions for power systems

Course Outcomes

CO1: Understand the background of the evolution of the Smart Grid (SG)

CO2: Comprehend communication technologies and real-time monitoring schemes of SG.

CO3: Analyse energy storage and its management on SG.

CO4: Apply performance analysis tools for SG.
CO5: Understand the standards and regulations for SG infrastructure

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4/PSO1	PO5/PSO2
CO1	1	-	-	-	-
CO2	3	-	1	2	2
CO3	3	2	2	2	2
CO4	3	2	2	2	2
CO5	2	-	1	-	-

Syllabus

Basic understanding of power systems. Evolution of power electronics in power system applications. Smart grid definition. Smart grid versus conventional grid. Smart grid technologies in generation, transmission, and distribution. Present development & International policies in the smart grid. Smart Grid – Overview and stakeholders.

Smart grid features – Distribution generation, Storage, Demand Dispatch (DD), Demand Response (DR), Advanced Metering Infrastructure (AMI), Wide Area Monitoring Protection and Control (WAMPAC), Wide Area Control System (WACS). Sensors – CT, PT; Devices – Intelligent Electronics Devices (IED), Phasor Measurement Unit (PMU), Phasor Data Concentrator (PDC), Relays, DR Switch; Cyber-physical systems, SCADA, and substation automation, V2G/G2V.

Secure Protocols and Intrusion Detection: Industrial communication protocols and their security implications: Modbus TCP/RTU, DNP3, IEC 61850. IEEE 1686, IEEE C37, and IEEE 2030.5- Design of Intrusion Detection Systems (IDS) and anomaly-based detection for substation and grid monitoring. Application of machine learning models for threat detection and behavior profiling in electrical networks.

Case study: Energy Management System, Dynamic energy storage management.

Textbooks/References

1. *James Momoh, "Smart Grid: Fundamentals of Design and Analysis", Wiley-IEEE Press, March 2012.*
2. *Janaka B. Ekanayake, Nick Jenkins, Kithsiri M. Liyanage, Jianzhong Wu, and Akihiko Yokoyama, "SmartGrid: Technology and Applications", Wiley, February 2012.*
3. *Nouredine Hadjsaid and Jean-Claude Sabonnadiere, "Smart Grids", Wiley-ISTE, May 2012.*
4. *Ali Keyhani and Muhammad Marwali, "Smart Power Grids 2011", Springer, 2011.*
5. *Mini S. Thomas, John Douglas McDonald, "Power System SCADA and Smart Grids", CRC Press, April 2015.*
6. *Vijay Madisetti and Arshdeep Bahga, "Internet of Things: A Hands-on Approach", Hardcover – Import, 2014.*
7. *Dr. Rajkumar K Dr. K. Gaayathry Dr. Gobimohan Dr. P. Ravi Kumar, "Renewable Energy Systems with Advanced Smart Grid Technologies", RADemics Research Institute, 2024.*

25AI658	**Wide Area Monitoring and Control**	**L-T-P-C: 3-0-0-3**

Pre-requisite: Nil

Course Objectives

- The course aims to provide a comprehensive understanding of Phasor Measurement Unit (PMU) technology and its applications in the power grid.

Course Outcomes

CO1: Understand the basics of Phasor Measurement Techniques and algorithms
CO2: Apply measurement techniques that can be adopted in PMU implementations
CO3: Analyze different methods of State estimation and optimal placement of PMU
CO4: Implement the real-time case studies of WAMS

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4/PSO1	PO5/PSO2
CO1	2	-	-	-	-
CO2	3	1	-	1	-
CO3	3	2	-	1	2
CO4	3	1	2	-	2

Syllabus

Basic Concepts and Definitions: SCADA vs PMU, Synchrophasors, Frequency, and ROCOF, Steady-State and Dynamic Conditions in Power Systems, Classical Phasor Versus Dynamic Phasor. Algorithms for Synchrophasors, Frequency, and ROCOF: Methods to Calculate Synchrophasors based on a Steady-State Model and Dynamic Signal Model, Evaluation of Frequency and ROCOF, Dynamic Behavior of Phasor Measurement Algorithms.
Phasor Measurement Units and Phasor Data Concentrators: WAMS architecture, Sensors for PMUs, International Standards for Instrument Transformers, Accuracy of Instrument Transformers, Transducer, Impact on PMU Accuracy, Hardware for PMU and PMU Integration, PMU Architecture, Data Acquisition, System, Synchronization Sources, Communication and Data Collector, Distributed PMU, Tests for Compliance, IEC 61850.
State Estimation and PMUs: Formulation of the SE Problem, Network Observability - SE Measurement Model, SE Classification, State Estimation with Phasor Measurements, Linear State Estimation, Dynamic Estimators. Optimal PMU placement, meta-heuristic and deterministic algorithms, Integer Linear Programming Technique. Introduction, Structure of WAMS Integrated in Control and Management Systems, Managing Oscillations in Power Systems, Managing Disturbances, Constraint Relief in Transmission and Distribution Systems.

Textbooks/References

1. *Antonello Monti, Carlo Muscas, Ferdinanda Ponci, "Phasor Measurement Units and Wide Area Monitoring Systems - From the Sensors to the System", Academic Press, 2016.*
2. *A.G. Phadke, J.S. Thorp, "Synchronized Phasor Measurement and Their Applications", Springer 2008.*
3. *Yong Li, Dechang Yang, Fang Liu, Yijia Cao, Christian Rehtanz, "Interconnected Power Systems: Wide-Area Dynamic Monitoring and Control Applications," Springer, 2015.*
4. *Fahd Hashiesh, M. M. Mansour, Hossam E. Mostafa Fahd Hashiesh, M. M. Mansour, Hossam E. Mostafa, Wide Area Monitoring, Protection and Control: The Gateway to Smart Grids, Lambert Academic Publishing, 2011.*

25AI659	**Energy Markets and Blockchain**	**L-T-P-C: 3-0-0-3**

Pre-requisite: Nil

Course Objectives

- To enable students to understand the functioning, pricing mechanisms, and regulatory environment of modern electricity markets.
- To equip students with knowledge of the impact of distributed energy resources and digital technologies on energy market transformation.
- To develop proficiency in applying blockchain and smart contract technologies in decentralized energy systems, with practical lab integration.

Course Outcomes

CO1: Understand the structure of modern energy markets and the associated regulatory frameworks.
CO2: Analyze the impact of distributed energy resources (DERs), Peer-to-Peer (P2P) energy systems, and digital transformation of market operations.
CO3: Understand the fundamentals of blockchain, consensus mechanisms, and smart contracts.
CO4: Design blockchain-based applications for energy trading, certification, and grid management scenarios.
CO5: Implement blockchain prototypes and simulate decentralized market models using tools.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4/PSO1	PO5/PSO2
CO1	1	-	-	-	-
CO2	3	2	2	1	2
CO3	2	-	-	-	-
CO4	3	2	2	3	3
CO5	3	2	3	2	3

Syllabus

Overview of Electricity Markets: Participants, Pricing, Market Types (Wholesale, Retail), Day-Ahead, Real-Time, and Ancillary Services Markets. Tariff Design: Time-of-Use, Dynamic Pricing, Net Metering. Regulatory Roles: ISOs, RTOs, Utility Models, Smart Grids, Impact of Renewable Integration on Market Design. Digitalization in Energy: Demand Response, Virtual Power Plants.

Introduction to DERs: Solar, Wind, Storage, Microgrids. Grid Economics with DERs: Load Shaping, Curtailment, Forecasting. Peer-to-Peer (P2P) Energy Trading Models and Mechanisms. Energy as a Service (EaaS), Community Grids, and Local Energy Markets. Locational Marginal Pricing (LMP) and Congestion Management. Case Studies: P2P Market Pilots, Community DER Initiatives.

Blockchain Basics: Structure, Consensus Algorithms, Types (Public, Private). Smart Contracts: Concepts, Use in Automation (Solidity Overview). Blockchain Platforms in Energy: Ethereum, Hyperledger, Power Ledger. Applications: P2P Energy Trading, Renewable Energy Certificates (REC), Carbon Markets. Secure Metering, Billing, and Settlement on Blockchain, Challenges and Future Outlook: Regulation, Scalability, Interoperability

Textbooks/References

1. *Hongjian Sun, Weiqi Hua, Minglei Yu, Blockchain and Artificial Intelligence Technologies for Smart Energy Systems, CRC Press (Taylor & Francis Group), 2021.*
2. *Peter Fox-Penner, Power after Carbon: Building a Clean, Resilient Grid, Harvard University Press, 2020.*
3. *Weiqi Hua et al., Applications of Blockchain and Artificial Intelligence Technologies for Enabling Prosumers in Smart Grids: A Review, 2022.*

4. *Yihao Guo et al., When Blockchain Meets Smart Grids: A Comprehensive Survey, 2021.*

25AI660	Hardware-in-Loop and Digital Twin	L-T-P-C: 2-0-3-3

Pre-requisite: Digital Signal Processing

Course Objectives

- To understand the role of HIL in system prototyping and validation.
- To explore the concept of Digital Twins and their integration with cyber-physical systems.
- To gain practical exposure to the tools, platforms, and frameworks used in HIL and Digital Twin development.
- To bridge the gap between simulation and real-world deployment through co-simulation and real-time interfacing techniques.

Course Outcomes

CO1: Understand the role of HIL in system prototyping and validation.
CO2: Design HIL test benches using simulation tools and embedded hardware.
CO3: Develop the architecture and lifecycle of a Digital Twin system.
CO4: Develop Digital Twin models using physical and data-driven approaches.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4/PSO1	PO5/PSO2
CO1	3	1	-	-	-
CO2	3	-	-	2	2
CO3	3	1	-	-	1
CO4	2	2	2	2	2

Syllabus

Introduction to Model-in-the-Loop (MIL), Software-in-the-Loop (SIL), and Hardware-in-the-Loop (HIL) - Need and advantages of HIL - Real-time simulation concepts, deterministic execution - I/O interface design and synchronization - Case studies: Automotive, Aerospace, Power Systems, Power Electronics & Drive applications.

Concept, definition, and lifecycle of a Digital Twin -Types of Digital Twins: Product, Process, and System Twins- Data flow between physical and digital systems - Virtual sensing and real-time analytics - Interfacing with IoT devices and cloud platforms (MQTT, OPC-UA, Azure IoT Hub). Case studies: Smart Grid, Manufacturing, Predictive Maintenance.

Coupling HIL systems with Digital Twins - Real-time data acquisition and feedback loops - Co-simulation frameworks: FMI/FMU standards, OpenModelica, Functional Mock-up Interface - Fault injection and scenario testing - Challenges: Latency, Security, Model fidelity. Future trends: AI-powered twins, Edge computing integration.

HIL Tools: MATLAB/Simulink Real-Time Environment, OPAL-RT, dSPACE, Typhoon-HIL, NI-DAQ.

Textbooks/References

1. *Franklin, G. F., Powell, J. D., & Emami-Naeini, A., "Feedback Control of Dynamic Systems ", 8th edition, Pearson, 2019.*

2. *Drath, R., "Integrated Simulation and Hardware-in-the-Loop (HIL) for Mechatronic Systems", VDI Verlag, 2010.*
3. *Tao, F., Sui, F., Liu, A., Qi, Q., Zhang, M., & Song, B., "Digital Twin Driven Smart Design", 1st Edition, Elsevier, 2020.*
4. *Zhang, W., Yang, D., & Wang, J., "Data-Driven Modeling for Digital Twin and Smart Manufacturing ", 1st Edition, Springer, 2021.*
5. *MathWorks. MATLAB Documentation and Toolboxes for HIL and Simscape Real-Time. Available at: https://www.mathworks.com/help*
6. *National Instruments (NI) and dSPACE GmbH. Technical Manuals and Application Notes. Available at:*
    a. *NI: https://www.ni.com/documentation/*
    b. *dSPACE: https://www.dspace.com/en/pub/home/support/documentation.cfm*

25AVP501 MASTERY OVER MIND 1-0-2-2

PG SYLLABUS

COURSE OBECTIVES

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 Amritanandamyi 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,	Remembering

	and principles discussed in the chapters on Sanatana Dharma, scriptures, and cultural aspects.	
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.** Statement: Create expressive projects that capture the essence of Sanatana Dharma, convey the practices of sadhana, and portray the cultural meanings of symbols.	Creating

POs Programme Outcomes	**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** **B.Tech. EEE Programme Specific Outcome (PSO)** **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	• 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.

innovative solutions.

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 ofScriptures
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
Chapter 13 - Sadhana

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 Sivanand*a

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, 3nd 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.

C05: 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

C06: 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, Cryptarithmetic 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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