

Master of Technology
in
Automotive Electronics

Curriculum & Syllabus-2026



Department of Electronics and Communication Engineering

Amrita School of Engineering

Amrita Vishwa Vidyapeetham,

Amritanagar, Coimbatore - 641112

Department of Electronics and Communication Engineering**Amrita School of Engineering, Coimbatore****Amrita Vishwa Vidyapeetham****M.Tech Programme in Automotive Electronics**

The M.Tech Programme in Automotive Electronics is designed to equip students with advanced knowledge and skills in the rapidly evolving field of automotive technology. This interdisciplinary program integrates principles from Electronics Engineering, Electrical Engineering, Computer science, Mechanical engineering, and Automotive technology to prepare graduates for careers at the forefront of innovation in the automotive industry.

The programme offers a unique blend of theoretical knowledge and practical experience through industry collaboration and hands-on sessions. Students benefit from access to campus wide state-of-the-art laboratories and facilities, enabling them to apply their learning in real- world scenarios. Moreover, this programme addresses current and future industry demands for professionals skilled in Automotive Electronics, ensuring graduates are competitive in the global job market.

The curriculum covers a comprehensive range of topics essential for understanding modern automotive systems and their electronic components. Students delve into courses such as Embedded Systems, Autonomous Driving, Software Defined Vehicles, Vehicular Networking, Automotive Safety and Reliability, Electric Vehicles, Automotive Systems Engineering, and Automotive Control System, to name a few, with extensive involvement from leading industry experts.

Graduates of this programme are well-positioned for a variety of roles in the automotive industry such as Systems Engineer, Validation Engineer, Hardware Design Engineer, Software Engineer, R&D firmware Engineer, Test Engineer and Data Scientist, etc.

The Master's Programme in Automotive Electronics equips students with the expertise needed to tackle the challenges and opportunities presented by the evolving automotive industry. By mastering the intricacies of automotive electronics, graduates contribute to shaping the future of transportation, making vehicles safer, more efficient, and increasingly connected.

Program Educational Objectives:

1. To advance knowledge and skills in automotive electronics, including Embedded Systems, Software Defined Vehicles, Autonomous Driving, Electric Vehicles, Automotive Power Electronics, Vehicle Networking, Automotive Safety and Reliability, Automotive Systems Engineering, and Automotive Control Systems, and solve complex engineering problems in the automotive industry.
2. To engage in research and development activities, contributing to the advancement of automotive electronics through innovation, new product development, and applied research projects.
3. To learn to incorporate principles of sustainability and environmental responsibility into their work in automotive electronics design, development, and implementation.

Program Outcomes:

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

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

PO3: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program.

PO4: Students should be able to demonstrate a deep understanding of principles, theories, and methodologies in automotive electronics, leading to specializations in Software Defined Vehicles, Autonomous Driving, and Electric Vehicles.

PO5: Students should be able to apply engineering principles and theoretical knowledge to solve complex problems in the design, development, and implementation of automotive electronic systems and components.

PO6: Students should be able to engage in research activities, applying critical thinking, problem-solving, and analytical skills to advance knowledge and contribute to innovations in automotive electronics.

Curriculum

Semester – I

Type	Code	Course Name	L	T	P	Credits
FC	26AL601	Data Science for Automotive Applications	3	0	0	3
FC	26AL602	Automotive Systems	3	0	2	4
FC	26AL603	E/E Architecture	3	0	0	3
SC	26AL604	Embedded Systems Design	3	0	0	3
SC	26AL605	Electric Vehicles	3	0	0	3
SC	26AL606	Automotive Control Systems	3	0	0	3
SC	26AL681	Data Science Lab	0	0	3	1
SC	26AL682	Embedded Systems Lab	0	0	3	1
HU	22ADM501	Glimpses of Indian Culture	2	0	1	P/F
HU	23HU601	Career Competency- I	0	0	3	P/F
HU	25AVP501	Mastery Over Mind (MAOM)	1	0	2	2
		Total	19	0	16	23

Semester – II

Type	Code	Course Name	L	T	P	Credits
SC	26AL611	Advanced Embedded Systems	3	0	0	3
SC	26AL612	Automotive Systems Engineering & Safety	3	0	0	3
SC	26RM604	Research Methodology	2	0	0	2
E		Elective - 1	3	0	0	3
E		Elective - 2	3	0	0	3
E		Elective - 3	3	0	0	3
SC	26AL683	Advanced Embedded Systems Lab	0	0	3	1
SC	26AL684	Systems Engineering Lab	0	0	3	1
SC	26AL685	Open Lab	0	0	3	1
HU	23HU611	Career Competency – II	0	0	3	1
SC	26AL698	Industry Internship*	0	0	2	1
HU	26CUL500	Integrated Amrita Meditation Technique	0	0	2	1
		Total	17	0	16	23

*The internship will be during the break between the second and third semesters. This will be evaluated based on a viva-voce and a written report.

Semester – III

Type	Code	Course Name	L	T	P	Credits
P	26AL798	Dissertation- Phase I	0	0	30	10
		Total	0	0	30	10

Semester – IV

Type	Code	Course Name	L	T	P	Credits
P	26AL799	Dissertation- Phase II	0	0	45	15
		Total	0	0	45	15

Total Credits: 71**Electives****Domain – Software Defined Vehicles**

Type	Code	Course Name	L	T	P	Credits
E	26AL731	Advanced Communication Systems	3	0	0	3
E	26AL732	Software Defined Vehicles	3	0	0	3
E	26AL733	Connected Vehicles and Security	3	0	0	3

Domain – Advanced Driver Assistance Systems (ADAS)

Type	Code	Course Name	L	T	P	Credits
E	26AL741	Deep Learning and Applications	3	0	0	3
E	26AL742	Perception and Control for Autonomous Driving	3	0	0	3
E	26AL743	Sensing for Autonomous Vehicles	3	0	0	3

Domain – Electrification

Type	Code	Course Name	L	T	P	Credits
E	26AL751	Battery and Battery Management Systems in EV	3	0	0	3
E	26AL752	Control of Power Converters and Electrical Drives	2	0	2	3
E	26AL753	Power Converters for Automotive Applications	2	0	2	3

26AL601**Data Science for Automotive Applications****3-0-0-3****Course Objectives**

- To provide a comprehensive understanding of data science principles, methodologies, and techniques relevant to automotive applications.
- To equip students with practical skills to collect, preprocess, analyze, and interpret data specific to the automotive industry.
- To familiarize students with supervised and unsupervised learning algorithms essential for predictive modeling in automotive systems.
- To develop students' ability to critically analyze automotive data, identify challenges, and propose data-driven solutions.

Course Outcomes**CO01:** Understand and preprocess diverse automotive data sources, including sensor data and telemetry.**CO02:** Apply regression, classification, and time series analysis to predict outcomes relevant to automotive systems.**CO03:** Implement and evaluate supervised and unsupervised machine learning algorithms for automotive data analysis.**CO04:** Evaluate and propose solutions to complex problems in automotive data science.**CO-PO Mapping**

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO01	3				2	2
CO02	3				2	2
CO03	3				2	3
CO04	3				2	3

Skills Acquired: Data Preprocessing, Visualization, Classification & Regression**Contents****Unit 1:**

Overview of Data Science: Definition, Importance, and Applications. Introduction to Automotive Industry: Trends, Challenges, and Opportunities. Role of Data Science in Automotive Applications. Data Sources in Automotive Industry: Sensors, Telematics, IoT. Data Collection Techniques: Real-time vs. Batch Processing. Data Preprocessing: Cleaning, Transformation, and Feature Engineering. Introduction to types of data analytics - descriptive, diagnostic, predictive, prescriptive. Probability Distributions and Hypothesis Testing. Introduction to Machine Learning Algorithms: Supervised vs. Unsupervised Learning.

Unit 2:

Regression Techniques: Linear, Polynomial, and Ridge Regression. Classification Methods: Logistic Regression, Decision Trees, Random Forests. Model Evaluation and Validation Techniques. Time Series Data in Automotive Applications - Predictive Maintenance.

Unit 3:

Principles of Data Visualization. Tools for Data Visualization. Dashboard Design for Automotive Analytics. Introduction to Deep Learning: Neural Networks, CNNs, RNNs. LSTM Networks for Time Series Prediction - Deep Learning Applications in Autonomous Vehicles and Image Recognition. Transfer Learning for Automotive Data. Case Studies - Predictive Maintenance in Automotive Industry- Autonomous Driving Algorithms and Challenges - Working with Real-world Data Sets. Introduction to Digital Twin.

Text / References:

1. Brunton, S. L., & Kutz, J. N, *Data-driven science and engineering: Machine learning, dynamical systems, and control*, Cambridge University Press, 2022.
2. Cady F, *The data science handbook*, John Wiley & Sons, 2017.
3. Grus J, *Data science from scratch: first principles with python*, O'Reilly Media, 2019.
4. Kroese, D. P., Botev, Z., & Taimre, T, *Data science and machine learning: mathematical and statistical methods*, Chapman and Hall/CRC, 2019.
5. Provost, F., & Fawcett, T, *Data Science for Business: What you need to know about data mining and data-analytic thinking*, O'Reilly Media, Incm, 2013.
6. Sarang P, *Thinking Data Science: A Data Science Practitioner's Guide*, Springer Nature, 2023.
7. Winner H., Prokop G, & Maurer, M. (Eds.), *Automotive Systems Engineering II* (Vol. 1). Switzerland: Springer, 2018.

26AL602**Automotive Systems****3-0-2-4****Course Objectives**

- To introduce concepts of Automotive systems.
- To provide the details of Automotive sub systems
- To provide the basic concepts of Advanced Driver Assistant Systems

Course Outcomes (CO):**CO01:** Able to understand the Automotive Industry**CO02:** Able to identify the mechanical systems used in Automotives**CO03:** Able to understand various vehicle domains and sub systems**CO04:** Able to understand various ADAS systems used in Automotives**CO-PO Mapping**

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO01	2	2	3			
CO02	2	2	3			
CO03	2	2	3			
CO04	2	2	3			

Skills acquired: Provide detailed insight on Automotive industry and various sub systems used in automotives

Unit 1:

Overview of Automotive Industry, Automotive Powertrain electronic systems: Sensors and actuators, Electronic control units, Engine management, electronic ignition systems, Engine management systems for diesel and petrol injection systems. Mechanical Subsystems: Steering, Braking, Transmission, Chassis and Suspension Systems

Unit 2:

Powertrain systems: sensors, actuators & control, Chassis and Body Electronic Systems: Sensors and actuators for chassis and body systems, Comfort and control systems: HVAC, vehicle security, driver comfort, signalling and vision, safety system, Chassis control systems: Longitudinal/ Lateral/ Stability Control – ABS, ESP, TCS, ACC, Active Suspension System, Automatic transmission. – Demo and Lab visit

Unit 3:

X-by-wire systems – Automotive alarm systems, Vehicle immobilization & deactivation, Driver information systems, Parking systems, Central locking system and electric windows – Occupants and driver safety systems: Seat belt lighteners and air-bags, Fault tolerant schemes, Driver assistance - ADAS Levels, Regulations and Euro NCAP – Type approvals – Tesla EV architecture- Other commercial vehicle system architectures, Demo and Lab visit.

Text / References:

1. William Ribbens, "Understanding Automotive Electronics – An Engineering Perspective", Eighth Edition, Butterworth Heinemann, 2017.
2. V.A.W. Hillier, Peter Coombes & David Rogers, Hillier's Fundamentals of Automotive Electronics, Book 2 – Powertrain Electronics, 5th Edition, Nelson Thornes Ltd, 2006.
3. W. Hillier and David R. Rogers, "Hillier's Fundamentals of Motor Vehicle Technology, Book 3 – Chassis and Body Electronics", Fifth Edition, Nelson Thornes Ltd, 2007.
4. Tom Denton, "Automobile Electrical and Electronic Systems", Fifth Edition, Routledge, 2018.
5. Robert Bosch GmbH, Bosch Automotive Electrics and Automotive Electronics - Systems and Components, Networking and Hybrid Drive, 5th Edition, Springer 2014

26AL603**E/E Architecture****3-0-0-3****Course Objectives**

- To introduce understand the Fundamental Concepts of Automotive Electronic Systems and Architectures
- To introduce automotive-Specific Communication Protocols and Networking
- To enable analyze Diagnostic Standards and Protocols in Automotive Systems

Course Outcomes:**CO01:** Understand E/E Architecture and Connected Car Systems**CO02:** Understand Automotive Communication Protocols**CO03:** Analyze and Apply OBD Standards and Diagnostic Protocols**CO04:** Evaluate Advanced Diagnostic Standards**CO-PO Mapping**

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO01	3		3	3		
CO02	3		3	3		
CO03	3		3	3	2	
CO04	3		3	3	2	2

Skills Acquired: E/E architecture, Automotive Communication Protocols, On-board Diagnostics

Unit 1:

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, Case Studies on Domain-Oriented and Zone-Oriented E/E Architecture, Centralized architecture to Software Defined Vehicles

Unit.2:

Overview of Automotive-Specific Communication protocols: CAN, CAN-FD, Automotive Ethernet, TCP/IP, SOME/IP, DDS, Protobuf, Introduction to Vehicular Networks: Controller Area Networks (CAN) - field of application- physical layer and bit -coding-frame types and format-Bit stuffing and synchronization-error management

Unit.3:

OBD Standards - Interface Controller - Applications - Overview of Automotive Ethernet protocols- Introduction to AUTOSAR - Classic and Adaptive, Automotive Ethernet, OBDII Diagnostic standards: UDP, SDV Diagnostic standards: DOIP.

Text / References

1. Richard Zurawski, *Industrial Communication Technology Handbook*, 2nd Edition, CRC Press, 2014.
2. Thomas Königseder and Kirsten Matheus, *Automotive Ethernet*, 3rd Edition, Cambridge University Press, 2021.
3. Gilbert Held, *Inter- and Intra-Vehicle Communications*, Auerbach Publications, 2007.

4. Dominique Paret, Roderick Riesco, *Multiplexed Networks for Embedded Systems: CAN, LIN, FlexRay, Safe-by-Wire*, John Wiley and Sons, 2007.
5. Andreas Grzempa, *MOST- The Automotive Multimedia Handbook*, Franzis Verlag GmbH, 2011.
6. Olaf Pfeiffer, *Implementing Scalable CAN Security with CANcrypt Authentication and encryption for the Controller Area Network (CANcrypt)*, Embedded Systems Academy GMBH, 2017.
7. Wilfried Voss, *Controller Area Network Prototyping with Arduino*, Copperhill Technologies Corporation, 2014

26AL604**Embedded Systems Design****3-0-0-3****Course Objectives**

To introduce design concepts of embedded systems.

To provide insights on embedded C programming for configuring microcontroller and peripherals

To enable development of embedded system models.

Course Outcomes

CO01: Able to identify the features of STM32F microcontroller

CO02: Able to apply embedded C programming skills for configuring STM32F peripherals

CO03: Able to analyze external peripheral interfacing with a microcontroller

CO04: Able to design and develop embedded systems using STM32F microcontroller

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO01	2		2		3	
CO02	2		2		3	
CO03	2		2		3	2
CO04	2		2		3	2

Skills acquired: STM32 Microcontroller, Peripheral interfacing, Design requirements

Unit.1:

Introduction to Embedded Systems - Introduction to ARM - Advanced RISC Features – Specifications of Automotive Grade Controllers with examples - Core Data path - Register Organization - System Architecture - Memory Organization - Low Power Modes - Power Control Registers - Backup Registers - Programming STM32F.

Unit.2:

STM32F Peripherals: Embedded C Programming - General Purpose Input Output - UART - ADC - DAC - Timers - Interrupts and Exceptions - PWM - SPI.

Unit.3:

External Peripheral Interfacing: LCD - Keypad - Motor - Servo Motor - EEPROM - Seven Segment Interfacing - Sensor Interfacing. Case Studies: ADAS system for Body Electronics and Infotainment applications (Selection of micro controller for Automotive as lab experiment).

Text / References

1. Shujen Chen, Eshragh Ghaemi, Muhammad Ali Mazidi, *STM32 Arm Programming for Embedded Systems*, Microdigitaled, 2019.
2. Donald Norris, *Programming with STM32: Getting Started with the Nucleo Board and C/C++*, McGraw-Hill Education, 2018.
3. *STM32F446xx advanced Arm®-based 32-bit MCUs, Reference Manual*, 2020.

26AL605**Electric Vehicles****3-0-0-3****Course Objectives:**

- To introduce standards, impacts and economy of electric vehicles
- To impart knowledge of electric and hybrid electric vehicle architectures
- To provide an understanding of subsystems in electric and hybrid electric vehicles
- To introduce battery testing, maintenance and monitoring techniques

Course Outcomes :**CO01:** Ability to understand standards, impact and economy of Electric Vehicles**CO02:** Ability to apply knowledge of vehicle subsystems for electric and hybrid electric configurations**CO03:** Ability to analyze the architectures of Electric and Hybrid Electric Vehicles**CO04:** Ability to design and simulate electric vehicle subsystems**CO-PO Mapping**

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO01	2		3		3	
CO02	2		3			2
CO03	2		3		2	3
CO04	2		3	2	2	3

Skills Acquired: Simulation and analysis of EV, HEV subsystems.

Unit 1:

Electric vehicles (EVs) - advantages and impacts - EV market and promotion - Infrastructure - International Regulation and standards – Power quality ratings – Homologation- AIS-038, AIS-039, AIS-040, AIS-049 - Energy efficiency - High Voltage standards for 400V systems - Assessing economy of EVs – xEVs- Fuel economy - Fuel consumption - Greenhouse gas emissions.

Unit 2:

ICE and xEV powertrain architectures and subsystems – Motors- Sizing and design considerations-Power converters- motor control – HIL Testing-Case studies: Development of MATLAB/Simulink models for EV.

Unit 3:

Energy storage systems - Batteries and battery parameters - Types and characteristics of EV batteries - Battery sizing -Battery testing - Battery monitoring – SoC and SoH- Integration of EV subsystems- EV Chargers - Onboard and off-board chargers - Introduction to charging standards and protocols.

Text / References

1. James Larminie, John Lowry, *Electric Vehicle Technology Explained*, 2nd Edition, John Wiley and Sons, 2012.
2. 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.
3. Sheldon S. Williamson, *Energy Management Strategies for Electric and Plug-in Hybrid Electric Vehicles*, Springer-Verlag New York, 2013.
4. Tom Denton, *Electric and Hybrid Vehicles*, Routledge, 2016.
5. Adit Joshi, *Automotive Applications of Hardware-in-the-Loop (HIL) Simulation*, SAE International, 2019.

26AL606**Automotive Control Systems****3-0-0-3****Course Objectives**

- Introduce students to the fundamental concepts of system modeling for control systems.
- Equip students with state space techniques for analyzing and designing control systems.
- Expose students to controller design and performance analysis principles, with a focus on automotive systems.

Course Outcomes**CO01:** Model the dynamics of automotive systems using mathematical techniques

CO02: Analyze automotive control systems using state space methods

CO03: Design control systems for automotive applications

CO04: Acquire knowledge about the utilization of CAD tools in the design of control systems for automotive applications.

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO01	2		3		3	
CO02	2			2		
CO03	2		2	2	2	2
CO04	2		3	2	3	2

Skills Acquired: Modeling and design of control systems, State variable representations, Optimal control
Unit 1:

Introduction - Need for control systems, Objectives of analysis and design, Design process. Laplace transforms review, Transfer functions - Examples of Electrical, mechanical and electro-mechanical systems Linearization concept with automotive examples. Overview of different types of controllers - PID controllers, semi-empirical tuning, controller design for a non- linear systems using gain scheduling.

Overview of robust control.

Unit 2:

State Variable Representation - State Variable Models to Transfer Functions - Transfer Functions to State Variable Models - Solution of State Equations. Concepts of Controllability and Observability.

Unit 3:

State Feedback- Regulator Design - Design of State Observers - Compensator Design by the Separation Principle. Optimal control – Active suspension system. Model predictive control. for– Lane keep assist system, Autonomous steering system. Introduction to machine learning concepts, Machine learning for Model predictive control, A case study using MATLAB/Python.

Text / References

1. M. Gopal, Digital Control and State Variable Methods: Conventional and Intelligent Control, TMH, Fourth edition, 2017.
2. Norman S. Nise, Control Systems Engineering, 8th Edition, John Wiley & Sons, 2019.
3. Richard C. Dorf, Robert H. Bishop, Modern Control Systems, 12th Edition, Pearson, 2010.
4. Katsuhiko Ogata, Modern Control Engineering, 5th Edition, Pearson, 2010.

26AL681

Data Science Lab

0-0-3-1

Course Objectives

- To introduce the concept of collecting and preprocess diverse automotive datasets including sensor data, maintenance logs.
- To impart hands-on experience in applying statistical analysis, regression, classification, clustering, and time series forecasting techniques to automotive data.
- To introduce complex automotive data problems, hypotheses, and data-driven solutions using a structured approach.

Course Outcomes

CO01: Identify and address challenges specific to automotive data science.

CO02: Acquire, clean, and preprocess diverse datasets from automotive sources, ensuring data readiness for analysis.

CO03: Visualize data effectively using appropriate tools and interpret results to support decision-making in automotive diagnostics.

CO04: Assess model accuracy, interpret results, and propose actionable recommendations based on predictive analytics and anomaly detection experiments.

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO01	3	3			2	2
CO02	3	3			2	2
CO03	3	3			2	3
CO04	3	3			2	3

List of Experiments

1. Exploratory Data Analysis (EDA) on Vehicle Telemetry Data - Analyze distribution, correlation, and outliers in real-time sensor data from a fleet of vehicles (e.g., temperature, pressure, RPM). Visualize trends and anomalies.
2. Predictive Maintenance Analysis - Predict the likelihood of part failure based on historical maintenance logs including repair dates, parts replaced, and mileage using classification algorithms like Decision Trees or Random Forests.
3. Fault Diagnosis using Sensor Data – Build a model to classify fault types based on Diagnostic trouble codes (DTCs) from onboard diagnostics (OBD) systems.
4. Anomaly Detection in Vehicle Performance - Detect anomalies in Performance metrics (e.g., fuel efficiency, engine power) across different driving conditions using statistical methods (e.g., Z- score, Isolation Forest) and visualize anomalies.
5. Image Recognition for Traffic Sign Detection - Develop a machine learning network model to detect and classify traffic signs (Images captured from vehicle-mounted cameras showing traffic signs) for autonomous driving applications.
6. Predictive Modeling for Vehicle Component Lifespan - Build a regression model to predict component lifespan of vehicle components (e.g., batteries, tires) based on usage and environmental conditions, using linear regression or survival analysis techniques.
7. Health Monitoring of Hybrid/Electric Vehicle Batteries - Develop a health monitoring system using time series analysis to predict battery degradation and failure using the Battery performance metrics (e.g., voltage, current, temperature) from hybrid/electric vehicles.
8. Driver Drowsiness Detection using Biometric Sensors - Build a classification model to detect driver drowsiness based on biometric sensor data (e.g., heart rate, eye movement collected from drivers during different driving conditions), using machine learning algorithms.

26AL682**Embedded Systems Lab****0-0-3-1****Course Objectives**

- To provide design concepts on implementation of Embedded Systems
- To provide insight on communication protocols used in embedded domain
- To demonstrate internal peripheral configuration of a microcontroller platform
- To demonstrate external peripheral configuration of a microcontroller platform

Course Outcomes:

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

CO01: Ability to interface external peripherals with a programmable platform

CO02: Ability to implement and analyze serial communication protocol

CO03: Ability to design and implement embedded system or machine learning based solutions for a specific application

CO04: Ability to analyze and optimize the performance of the given embedded system

CO-PO Mapping:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO01	2	3	3		3	
CO02	2	3	3		3	

CO03	2	3	3		3	2
CO04	2	3	3		3	3

Skills Acquired: Configuration of peripherals of STM32, Embedded System Development using Cortex M4 Microcontroller

Contents

1. General Purpose Input Output Programming
2. Serial Data Transfer Implementation in Automotive domain
3. Sensor and actuator control for embedded applications
4. Precise timing and control of automotive systems
5. Real Time PWM generation and control of Servo Motors
6. Emergency Control of Automotive Systems using Interrupt
7. Speed Control of DC and Stepper Motor for Electric Vehicles
8. Drive By Wire System Implementation
9. Drive Recorder Implementation for Automobiles
10. Multiple Node Communication and Control using CAN

Reference (s)

1. Muhammad Ali Mazidi, STM32 Arm Programming for Embedded Systems, 2019.
2. Donald Norris, Programming with STM32: Getting Started with the Nucleo Board and C/C++, McGraw-Hill Education, 2018
3. STM32F446xx advanced Arm®-based 32-bit MCUs, Reference Manual, 2020

26AL611

Advanced Embedded Systems

3-0-0-3

Course Objectives

- To provide an insight on multi-core architecture and programming
- To introduce the concepts of Real Time Operating Systems
- To impart knowledge on parallel computing using Graphical Processing Units (GPU)
- To introduce architecture and core concepts of the QNX RTOS

Course Outcomes:

CO01: understand the concepts of multi-core processor system

CO02: apply advanced peripheral programming techniques

CO03: analyze task handling and its real time scheduling

CO04: implement programming models using GPU

CO05: understand the concepts of task handling using QNX RTOS

CO-PO Mapping:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO01	2		3		3	
CO02	2		3		3	
CO03	2		3		3	2
CO04	2		3		3	3
CO05	2		3		3	3

Skills Acquired: Configuration of peripherals of an advanced processor, CUDA programming using GPU, QNX configuration

Unit 1:

Aurix Architecture Overview – On-Chip System Buses – Memory Maps – CPU Subsystem – System Control Unit– Program Memory Unit – Local Memory Unit (LMU) – Data Access Overlay (OVC) - Multicore Task Management – UART DMA – ADC Group Scan – Interrupt Programming

Unit 2:

Task Management - tasks, process and threads, task attributes and types - task states and transition, preemption-context switching, task control block, Introduction to real-time task scheduling, scheduling algorithms. Blocking, Deadlock and avoidance strategies, priority inversion and solutions. Task Communication and Synchronization - Semaphores and Mutex, Mailbox, Queue. Shell Programming - operating systems services – system calls - Process and Processor management: Process concepts – process scheduling – operations on process.

Unit 3:

Overview of parallel computing - CPU Vs GPU - Basics of GPU architecture - Introduction to CUDA - CUDA programming basics - CUDA threads, blocks, and grids - Memory hierarchy in CUDA (shared memory, global memory) - vector addition - Kernels - Thread Hierarchy - Thread Block Clusters - Memory Hierarchy - Heterogeneous Programming. Overview of QNX OS architecture – microkernel - process manager - Protected address spaces - process/thread model – scheduling - message passing - IO-mapped and memory-mapped IO

Reference (s)

1. AURIX™ TC21x/TC22x/TC23x Family 32-Bit Single-Chip Microcontroller, User Manual, Infineon Technologies AG, 2015
2. Richard Barry, Mastering the FreeRTOS™ Real Time Kernel a Hands-On Tutorial Guide, Real Time Engineers Ltd., 2016
3. CUDA C++ Programming Guide, NVIDIA, 2024
4. Abraham Silberschatz, Peter B. Galvin, Greg Gagne, Operating System Concepts, 9th Edition, Wiley, 2018.
5. QNX Neutrino RTOS User's Guide, QNX Software Systems.

26AL612

Automotive Systems Engineering and Safety

3-0-0-3

Course Objectives :

- To introduce topical concepts and elements in systems engineering.
- To offer insights on systems engineering schemas and related software development.
- To impart knowledge on prevalent safety standards in vehicular system development

Course Outcomes:

CO01: Ability to understand salient concepts in automotive systems engineering

CO02: Ability to analyze and process model-based systems engineering

CO03: Ability to design and implement data driven systems engineering

CO04: Ability to understand safety standards applied to vehicular system development

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO01	3		2			
CO02	3		2		2	
CO03	3		2		2	3
CO04	3		2		2	2

Skills acquired: Concepts and tools deployed in design-for-safety of vehicular systems.

Unit 1

System Engineering - Introduction - Need of systems engineering – Lifecycle - System Elements - System of systems – Processes overview - Analytics Tools - Technical process details – Optimize system architectures – Requirements and Needs Analysis – Process models – V-model, agile and iterative models

Unit 2

Model based systems Engineering- Introduction Methodology, Digital thread - architecture models - implementation models - embedded software. Model Based development – MBD Tools - Introduction to data flow and state flow modelling - Tool boxes for automotive control system development and simulation ASPICE and AI-supported v/v.

Unit 3

Functional Safety – Introduction - Overview of ISO26262: (Part 2 to part 9) - Safety lifecycle – Concept phase (part 3) – System Phase (part 4) - Hardware development (part 5) - Software development (part 6) - Verification, Validation – Traceability and certification in safety-critical systems – MISRA C – Automotive System, AI and Software Coding Safety Standards.

References

1. James Wen, "Data Driven System Engineering: Automotive ECU Development", pp. 260, Ddse Consulting LLC, 2022.
2. Andrea Leitner, Daniel Watzenig and Javier Ibanez-Guzman, "Validation and Verification of Automated Systems", 1(11), pp. 320, Springer Nature Switzerland AG, 2020.
3. John M. Borky & Thomas H. Bradley, "Effective Model-Based Systems Engineering", 1(20), pp.779, Springer Cham, 2019.
4. Markus Maurer & Hermann Winner, "Automotive Systems Engineering", 1(8), pp. 268, Springer Berlin, Heidelberg, 2013.
5. Arrichiello, Vincenzo. Introduction to Systems Engineering. CIISE, 2014.
6. Bonjour, Eric. "Special Issue on System of Systems Engineering," Wiley-Blackwell, 2019.
7. David D. Waldenm "INCOSE Systems Engineering Handbook", Wiley, 4th edition, 2015.
8. INCOSE-UK. SERC, and IEEE-SYSC, "Guide to the Systems Engineering Body of Knowledge (SEBoK)", Stevens Institute of Technology, ver. 2.10, 2024.

26RM604**Research Methodology****2-0-0-2****Course Objectives**

- To enable defining and formulating research approaches towards obtaining solutions to practical problems.
- To facilitate development of scientific oral and written communication skills.
- To comprehend the concepts behind adhering to scientific ethics and values.

Course Outcomes (CO)

CO01: Ability to understand some basic concepts of research and its methodologies.

CO02: Ability to define and apply appropriate parameters and research problems.

CO03: Ability to develop skills to draft a research paper.

CO04: Ability to analyse and comprehend the ethical practices in conducting research and dissemination of results in different forms.

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO01	2	3	3	2	3	3
CO02	2	3	3	2	3	3
CO03	2	3	3	2	3	3
CO04	2	3	3	2	3	3

Skills Acquired: Design, analyse and conduct research and comprehend the results.

Contents

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, Tables and illustrations, Guidelines for writing the abstract, introduction, methodology, results and discussion, conclusion sections of a manuscript. References, Citation and listing system of documents Intellectual property rights (IPR) - patents-copyrights- Trademarks-Industrial design geographical indication. Ethics of Research- Scientific Misconduct- Forms of Scientific Misconduct. Plagiarism, Unscientific practices in thesis work, Ethics in science.

References

1. Borden, K. S. and Abbott, B. B., Research Design and Methods – A Process Approach, 8th Edition, McGraw-Hill, 2011.
2. C. R. Kothari, Research Methodology – Methods and Techniques, 2nd Edition, New Age International Publishers.
3. Davis, M., Davis K., and Dunagan M., Scientific Papers and Presentations, 3rd Edition, Elsevier Inc.
4. Michael P. Marder, Research Methods for Science, Cambridge University Press, 2011.
5. T. Ramappa, Intellectual Property Rights Under WTO, S. Chand, 2008.
6. Robert P. Merges, Peter S. Menell, Mark A. Lemley, Intellectual Property in New Technological Age, Aspen Law & Business, 6th Edition July 2012.
7. Tony Greenfield and Sue Greener, Research Methods for Postgraduates, 3rd Edition, John Wiley & Sons Ltd., 2016

26AL683

Advanced Embedded Systems Lab

0-0-3-1

Course Objectives

- To implement peripheral configuration in an advanced microcontroller
- To implement concepts of multicore programming
- To implement programming experiments using Graphical Processing Unit
- To implement Task Management using QNX

Course Outcomes:

CO01: understand the configuration of peripherals in an advanced microcontroller

CO02: apply multicore programming techniques

CO03: analyze utilization of GPU resources

CO04: implement CUDA programs in GPU hardware

CO05: implement QNX processes and task management

CO-PO Mapping:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO01	2	3	3		3	
CO02	2	3	3		3	
CO03	2	3	3		3	2
CO04	2	3	3		3	3
CO05	2	3	3		3	3

Skills Acquired: Configuration of peripherals of an advanced processor, CUDA programming using GPU, QNX implementation

Contents:

1. Data Transfer from UART through DMA
2. Group Scan using ADC
3. Fault Signaling Protocol implementation using Safety Management Unit
4. CPU Trap recognition and handling

5. Shared and Global Memory Implementation using Cuda
6. Analysis of Cuda Thread and Block using GPU
7. Implementation of Wrap Divergence using Cuda
8. Legacy code conversion to multicore environment
9. QNX configuration and application development using QNX
10. Process and thread creation, management, and synchronization using QNX
11. Implementation of IPC methods using message passing in QNX
12. Building and deploying QNX boot/OS images.

Reference (s)

1. AURIX™ TC21x/TC22x/TC23x Family 32-Bit Single-Chip Microcontroller, User Manual, Infineon Technologies AG, 2015
2. Jaegeun Han, Bharatkumar Sharma, Learn CUDA Programming A beginner's guide to GPU programming and parallel computing with CUDA 10.x and C/C++, Packt Publishing, 2019
3. CUDA C++ Programming Guide, NVIDIA, 2024
4. QNX Neutrino RTOS User's Guide, QNX Software Systems.

26AL684**System Engineering Lab****0-0-3-1****Course Objectives:**

- To instantiate systems engineering using software tools.
- To offer insights on systems engineering related software development.
- To incorporate the prevalent safety standards in vehicular system development

Course Outcomes :**CO01:** Ability to understand salient concepts in automotive systems engineering**CO02:** Ability to analyze and process model-based systems engineering**CO03:** Ability to design and implement model-based systems engineering**CO04:** Ability to apply prevalent safety standards in vehicular system development**CO-PO Mapping**

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO01	3	3	2			
CO02	3	3	2		2	
CO03	3	3	2		2	3
CO04	3	3	2		2	2

Lab Course Contents:**Exp. No Experiment Details**

- 1 **ASIL compliance in safety critical systems**
 1. Validate based on ISO26262 (Parts 5 & 6)
- 2 **Building a project management plan; and, hence, deriving and analysing project requirements**
 1. Creating a PMP Document
 2. Creating an Action Diagram
 3. Adding Information to the Project Plan
 4. Creating a Project Timeline Diagram
 5. Decomposing and Transforming Requirements in a Document
 6. Adding Decision, Issue and Query Entities to the Project Database

Exp. No Experiment Details

- 3 **Developing and executing a scenario model**
 1. Creating the Scenario Mode Physical I/O
 2. Creating an action diagram with I/O
 3. Creating an Action Diagram to Represent Different Scenarios
 4. Decomposing a Scenario
 5. Performing Discrete Events Simulation
- 4 **Identifying potential implementation strategies on the scenario model**
 1. Adding attributes to a class using the Schema Editor
 2. Creating Assets with Newly Defined Attributes
 3. Creating a Label in the Schema Editor
 4. Adding and Organizing New Rover Labels in the Database
- 5 **Identification of the appropriate trade studies**
 1. Adding Trade Study Artifacts to the Database
 2. Inserting the Trade Studies into the Project
 3. Connecting the Requirements to the Trade Study
- 6 **Creating of optimized model and its design monitoring**
 1. Downloading and Extracting / synthesising system CAD File
 2. Creating an Asset Hierarchy of the System
 3. Adding both Directions of the “References” Relationship to Pinned
 4. Creating Artifacts for Existing Asset Entities
- 7 **Creating test cases and suites**
 1. Adding a “Verifies” Relationship to a module of the system
 2. Adding a Traceability Matrix
 3. Documenting an Identified Issue
 4. Adding Relationships to Finish Tracking the Issue
 5. Tracing Issues via a Spider Diagram

Domains: HVAC, Powertrain, Transmission, Chassis, Braking & tyres, Electrical (battery; recovery; wiring harness), Infotainment, Sensors, Communications (full stack), ECU, ADAS/AV

References:

1. P Patankar and S Kulkarni, “MATLAB and Simulink In-Depth”, BPB Publications, pp. 602, 2022.
2. R Aarenstrup, “Managing Model-Based Design”, The MathWorks, Inc., pp. 94, 2015.
3. D K Chaturvedi, “Modeling and Simulation of Systems Using MATLAB and Simulink”, CRC press, pp. 734, 2017.

26AL685

Open Lab

0-0-3-1

Course Objectives

- To impart practical knowledge of modern automotive electronic systems and enabling technologies used in intelligent vehicles.
- To provide a common experimental platform for students to explore design, simulation, implementation, and validation techniques in automotive applications.
- To encourage interdisciplinary learning and innovation across software-defined vehicles, autonomous systems, and vehicle electrification domains.

- To develop problem-solving, analytical, and research skills through hands-on experimentation and open-ended laboratory activities.
- To familiarize students with state-of-the-art tools, hardware platforms, and industry-oriented development practices in automotive engineering.

Course Outcomes

CO01: Ability to identify and analyze engineering problems related to modern automotive systems.

CO02: Ability to apply appropriate software and hardware tools for modeling, simulation, implementation, and testing of automotive applications.

CO03: Ability to design and validate automotive subsystems using interdisciplinary engineering concepts.

CO04: Ability to conduct experiments, interpret results, and evaluate system performance under practical operating conditions.

CO05: Ability to carry out independent learning, innovation, and research-oriented activities in emerging automotive technologies.

CO06: Ability to effectively document, present, and communicate technical findings related to automotive engineering projects.

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO01	3	2	2	3	3	2
CO02	2	2	3	3	3	2
CO03	3	2	3	3	3	2
CO04	3	2	2	2	3	3
CO05	3	2	2	3	2	3
CO06	2	3	2	2	2	2

Description: Students will have to complete an exclusive project that incorporates concepts from all the courses under the specialization through the three electives opted for in Semester 2. The project has to be demonstrable with sufficient hardware and software components.

26AL731

Advanced Communication Systems

3-0-0-3

Course Objectives

- To provide an insight on vehicular communication systems
- To provide an insight on Automotive Ethernet
- To impart knowledge on Data Distribution Service and Protocol Buffers

Course Outcomes:

CO01: understand the concepts of in-vehicle communication

CO02: understand the automotive environment and its challenges

CO03: analyze the usage of middleware in automotive domain

CO04: understand the concepts of Data Distribution Service (DDS) and Protocol Buffers

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO01	2		2	3	3	
CO02	2		2	3	3	
CO03	2		2	3	3	2
CO04	2		2	3	3	2

Skills Acquired: Advanced vehicular communication technologies, Automotive Ethernet, DDS and Protocol Buffers

Unit 1:

Role of In-vehicle networking – Overview of CAN-FD – Improved Error Detection Capabilities – Fault Types – Classification of Errors - Calculation of Oscillator Tolerance – Phase Margin – Evaluation of Phase Margin - Overview of Ethernet – Challenges – 100BASE-TX Ethernet - Industry-Wide Acceptance of Ethernet

Unit 2:

Introduction to Automotive Environment - The Automotive Communication Channel – Channel Parameters Automotive Physical Layer Technologies: TCP/IP, 100BASE-T1 Channel - Internet Protocol – Middleware – SOME/IP Features – Header Format – Service Discovery - Security Requirements in the Automotive Industry – Network Security Solutions

Unit 3:

Overview of DDS – Components - Architectural Concepts and Entities - Type System - QoS Model - Guidelines for Building System of Systems with DDS – Overview of Protocol Buffers – Message Structure - Serialization and deserialization - Accelerator Design: Accelerator memory management – Serializer and Deserializer unit.

Reference (s)

1. Arthur Mutter, Florian Hartwich, *Advantages of CAN FD Error detection mechanisms compared to Classical CAN*, Robert Bosch GmbH, iCC 2015, 2015
2. Arthur Mutter, *Robustness of a CAN FD Bus System – About Oscillator Tolerance and Edge Deviations*, Robert Bosch GmbH, iCC 2013, 2013
3. Kirsten Matheus, Thomas Königseder, *Automotive Ethernet*, Third Edition, Cambridge University Press, 2021
4. Angelo Corsaro, Douglas Schmidt, *The Data Distribution Service: The Communication Middleware Fabric for Scalable and Extensible Systems-of-Systems*, 2012
5. Sagar Karandikar, Chris Leary, Chris Kennelly, Jerry Zhao, Dinesh Parimi, Borivoje Nikolić, Krste Asanović, Parthasarathy Ranganathan, *A Hardware Accelerator for Protocol Buffers*, MICRO '21, ACM, 2021
6. Clément Jean, *Protocol Buffers Handbook: Getting deeper into Protobuf internals and its usage*, Packt Publishing, 2024

26AL732**Software Defined Vehicles****3-0-0-3****Course Objectives:**

- To introduce software defined vehicles fundamentals and communication stack
- To impart knowledge on middleware based on Adaptive AUTOSAR
- To provide insights on virtualization, hypervisor and containers

Course Outcomes:

CO01: Ability to understand software defined vehicle architecture in terms of hardware and software.

CO02: Ability to define and realize Adaptive AUTOSAR based software

CO03: Ability to understand virtualization techniques

CO04: Ability to understand containerization techniques

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO01	2		2	3	3	
CO02	2		2	3	3	
CO03	2		2	3	3	2
CO04	2		2	3	3	2

Skills Acquired: Understanding of SDV and its communication stack; software architecture realization using Adaptive AUTOSAR, Virtualization, Hypervisors and Containers.

Unit.1:

Introduction to Software Defined Vehicle – E/E Architecture evolution – High Compute Platforms – Zonal Controllers – Traditional SW Architecture vs SDV SW Architecture – Introduction to Industry Consortiums and Alliances – Service Oriented Architecture/Communication – SOME/IP – Introduction to Protobuf, DDS

Unit.2:

AUTOSAR Overview – Evolution of AUTOSAR – Introduction to Adaptive AUTOSAR – Adaptive AUTOSAR architecture – Configure and deploy an Adaptive AUTOSAR service and demonstrate communication over SOME/IP or DDS – Communication Management – Lifecycle Management – Update and Configuration Management – Linux & Qemu Basics – Adaptive Application and Platform realization examples – Diagnostics and calibration: Overview and significance; Tool-based analyses using UDS and DoIP.

Unit.3:

Virtualization (Onboard) – Approaches – Introduction to Hypervisor – Types of Hypervisor – Utilization of Hypervisor in Automotive – Introduction to Containerization – Container Technology (Onboard to Offboard) – Applicability to Automotive – Cloud deployment vs Onboard deployment.

References:

1. Dirk Slama, Achim Nonnenmacher, Thomas Irawan, "The Software-Defined Vehicle", O'Reilly Media, 2023
2. Plato Pathrose, "Software Defined Vehicles R-595", SAE International, 2025.
3. TI SDV reference designs, 2026.
4. TI Software-defined vehicle design resources, 2026.
5. Software-defined vehicle DevOps toolchain, <https://learn.microsoft.com/en-us/industry/mobility/architecture/software-definedvehicle-reference-architecture-content>, 2026.
6. COVESA: Vehicle signal specification (VSS), <https://covesa.global/vehicle-signalspecification>, 2025.
7. DeepSeek: deepseek-ai/deepseek-llm-7b-chat. Hugging Face model repository, <https://huggingface.co/deepseek-ai/deepseek-llm-7b-chat>, 2024.
8. n8n: Powerful workflow automation software & tools: n8n, <https://n8n.io>, 2025.

26AL733

Connected Vehicles and Security

3-0-0-3

Course Objectives:

- To introduce the intersection of automotive technology and cybersecurity
- To facilitate understanding of the challenges, solutions, and implications of connected vehicles in modern transportation systems.

Course Outcomes:

CO01: Understand the architecture and components of connected vehicles.

CO02: Understand the unique cyber security threats and vulnerabilities in connected vehicles.

CO03: Understand current and emerging technologies for securing connected vehicles.

CO04: Understand the security aspects in OTA

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO01	2		2	3	3	
CO02	2		2	3	3	
CO03	2		2	3	3	2
CO04	2		2	3	3	2

Skills Acquired: Connected Vehicles, Secure Communication Protocols, OTA architecture and standards

Unit.1:

Introduction to Connected Vehicles – Definition and components of connected vehicles – Communication Technologies and Protocols – Role of 5G in connected vehicles – Cellular Cloud computing and its technologies in connected vehicle ecosystems - Authentication and authorization mechanisms - Privacy concerns and mitigation strategies – challenges of vehicle connectivity – Overview to Telematics – Introduction to Big data and Data processing technologies for connected vehicles

Unit.2:

Overview of automotive cybersecurity – Key threats and vulnerabilities in connected vehicles & OTA – automotive cyber-attacks – Cryptography and Security Protocols - Public key infrastructure (PKI) and digital certificates – Secure communication protocols - Secure communication over CANFD, Ethernet – Fundamentals of Intrusion Detection and Prevention Systems (IDS/IPS), Overview of technologies supporting Cloud Security & Zero Trust Architecture

Unit.3:

Introduction to OTA in Automotive – OTA Architecture and Standards – Types of OTA updates – OTA update process strategies and lifecycle – DevOps to support OTA for SDV - Security Challenges in OTA Updates – Risks and threats associated with OTA updates – OTA Diagnostics– Integrity and authenticity and secure update delivery mechanisms – Future challenges in securing OTA updates.

Texts / References:

1. Houbing Song, Glenn A. Fink, and Sabina Jeschke, "Security and Privacy in Cyber-Physical Systems: Foundations, Principles, and Applications" Wiley, 2017
2. Bob McQueen, "Big Data Analytics for Connected Vehicles and Smart Cities", Artech House, 2017
3. Shiho Kim, Rakesh Shreshta, "Automotive Cyber Security Introduction, Challenges, and Standardization" Springer, Manuel Wurm, 2022
4. Jörg Schäuuffele, Thomas Zurawka, "Automotive Software Engineering, Principles, Processes, Methods, and Tools", SAE International, 2005.
5. Kirsten Matheus and Thomas Königseder, "Automotive Ethernet", Cambridge University Press, 2021.
6. Hussein T. Mouftah, Melike Erol-Kantarci, Sameh Sorour, "Connected and Autonomous Vehicles in Smart Cities", CRC Press, 2020.

26AL741**Deep Learning and Applications****3-0-0-3****Course Objectives**

- To introduce the artificial neural networks and their architecture
- To impart knowledge of artificial neural networks design for classification and sequence analysis.
- To provide insight on design and deployment of deep learning models for machine learning problems.

Course Outcomes

CO01: Ability to understand the mathematics behind functioning of artificial neural networks.

CO02: Ability to analyze the given dataset for designing a neural network-based solution.

CO03: Ability to carry out design and implementation of deep learning models for signal/image processing applications.

CO04: Ability to design and deploy simple deep learning solutions to classification problems.

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO01	2		2	3	3	
CO02	2		2	3	3	2
CO03	2		2	3	3	3
CO04	2		2	3	3	3

Skills acquired: Deep learning models, Generative AI, reinforcement Learning

Unit.1:

Introduction to autonomous driving-Autonomous driving technologies-Autonomous driving algorithms - Perception in autonomous driving - Deep learning in autonomous driving perception -The Neuron - Feed-Forward Neural Networks - Linear neurons and their limitations – Activation functions - Training feed forward neural networks - Gradient descent - Delta rule and learning rates - Backpropagation algorithm - Stochastic and minibatch gradient descent - Preventing overfitting - Momentum-Based optimization-Learning rate adaptation.

Unit.2:

Convolutional Neural Networks (CNN) architecture - Accelerating training with batch normalization - Visualizing learning in convolutional networks - Embedding and representation learning - Autoencoder architecture - Denoising - Sparsity in autoencoders – Introduction to GAN : Examples in Automotive Domains

Unit.3:

Models for sequence analysis, Recurrent Neural Networks - Vanishing gradients - Long Short - Term Memory (LSTM) Units - Augmenting Recurrent networks with Attention - Deep Generative Networks - Generative Adversarial Networks - Deep Reinforcement Learning - Explore versus Exploit - Policy versus Value learning - Q-Learning and Deep Q-Networks – Introduction to Generative AI and Federated Learning: Examples in Automotive Domains.

References

1. Nikhil Buduma, *Fundamentals of Deep Learning: Designing Next-Generation Machine Intelligence Algorithms*, O'Reilly, 2017.
2. Shaoshan Liu, Liyun Li, Jie Tang, Shuang Wu and Jean-Luc Gaudiot. *Creating Autonomous Vehicle Systems*, Morgan & Claypool Publishers, 2018.
3. Ian Goodfellow, Yoshua Bengio and Aaron Courville, *Deep Learning*, MIT Press, 2016.
4. Aurélien Géron, *Hands-On Machine Learning with Scikit-Learn and TensorFlow*, O'Reilly, 2017.
5. Nikhil Ketkar, *Deep Learning with Python: A Hands-on Introduction*, Apress, 2017.

26AL742

Perception and Control for Autonomous Driving

3-0-0-3

Course Objectives

- To introduce advanced perception algorithms, multi-sensor data fusion techniques for autonomous vehicle navigation and environment.
- To provide knowledge on master vehicle dynamics control through PI-PID and AI-based methods for longitudinal and lateral vehicle control.
- To develop proficiency in data-driven development practices for autonomous vehicle systems.

Course Outcomes:

CO01: implement data fusion and path planning algorithms for autonomous vehicles.

CO02: implement vehicle dynamics modeling and control using PI-PID, AI-based methods

CO03: development data-driven systems, data collection to CI/CD

CO04: create systems for real-world challenges in autonomous driving

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO01	2		2	3	3	
CO02	2		2	3	3	
CO03	2		2	3	3	3
CO04	2		2	3	3	3

Skills Acquired: Perception algorithms, Optimization of Autonomous systems, Multi-Sensor Data fusion

Unit 1:

Perception Systems in Autonomous Driving: Introduction to Autonomous Driving Perception - Overview of autonomous driving, Importance of perception systems, Key sensors: Cameras, LIDAR, RADAR, Ultrasonic – Introduction to Multi-Sensor Data Fusion (MSDF) Algorithms - Applications in autonomous vehicles, Overview of Simultaneous Localization and Mapping (SLAM) - Visual SLAM and LIDAR-based SLAM, - Free Space Detection and Identification - Algorithms for free space detection, Applications in navigation and path planning.

Unit 2:

Control Systems for Autonomous Driving: Introduction to vehicle dynamics, Longitudinal and lateral control, Modeling vehicle dynamics - Control Algorithms. Applications in autonomous vehicles - Introduction to AI-based control, Machine learning and reinforcement learning for control, Case studies and applications - Integrated Control Systems - Combining traditional and AI-based control methods, Challenges and solutions. Advanced Control Techniques Future trends in vehicle control.

Unit 3:

Data-Driven Development for Autonomous: Data Collection and Management - Synchronizing data collection from multiple sensors, Event-based data collection, Data ingestion and storage - Data Processing and Analytics - Pre-processing techniques, Data analysis for autonomous driving, Virtualization in Autonomous Vehicle Development - Role of virtualization, Tools and techniques, Benefits and challenges - Case Studies and Future Directions

Reference (s)

1. Shaoshan Liu, Liyun Li, and Jie Tang, *Machine Learning for Autonomous Vehicles*, Springer, 2022.
2. Sebastian Thrun, Wolfram Burgard, and Dieter Fox, *Probabilistic Robotics*, MIT press, 2006.
3. Rajesh Rajamani, *Vehicle Dynamics and Control*, Springer, 2012.
4. Steven L. Brunton and J. Nathan Kutz, *Data-Driven Science and Engineering*, Cambridge University Press, 2019.

26AL743**Sensing for Autonomous Vehicles****3-0-0-3****Course Objectives**

- To provide insight into the principles of 2-D and 3-D digital signal processing
- To impart understanding the role of RF sensors in self-driving vehicular platform operations
- To enable the realization in functionality of various other ADAS sensor systems

Course Outcomes

CO01: Ability to understand various sensors in automotive systems

CO02: Ability to understand the principles of image and video signal processing

CO03: Ability to apply RADAR sensors and operations in self-driving vehicular platforms

CO04: Ability to analyze the functioning of various other sensor systems as part of ADAS

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO01	2		2	3	3	
CO02	2		2	3	3	
CO03	2		2	3	3	3
CO04	2		2	3	3	3

Skills Acquired: Vehicle sensors, Automotive sensor integration and fusion, Scenario extraction

Unit 1:

Autonomous vehicle sensor categories - Visible light imaging sensors – Intrinsic and Extrinsic camera parameters in Machine vision – Stereo vision vs Monocular vision cameras: Wide angle, HD – Lens distortion and correction – Image correspondence and Stitching (Surround 360 Camera) – Camera based object detection -AI-Based Computer Vision.

Unit 2:

Automotive RADAR types - Radio frequency bands and standards – 2D, 3D and 4D Radars - RADAR frequencies, Wave shapes, detection, False positives and signal processing. LIDAR: Conventional and Imaging: Solid State vs Rotating type LIDARS - Reconstruction of point - cloud data – LIDAR/ RADAR based object detection-Scenario generation for safety testing.

Unit 3:

GPS, GNSS and IMU sensors and sensing systems, Differential GPS, Ultrasonic sensors, Sensors for V2X Communication (DSRC / CV2X), Object tracking using RADAR, LiDAR and Camera based sensors, Case Studies: Pedestrian detection and tracking, Sign board detection, Trajectory prediction using AI.

References:

1. Hanky Sjafrie, *Introduction to Self-Driving Vehicle Technology*, First Edition, Chapman & Hall/CRC, 2019.
2. H. Winner et al. (Eds.), *Handbook of Driver Assistance Systems*, Springer Cham, 2016.
3. Luca Venturi and Krishtof Korda, *Hands-on Vision and Behavior for Self-Driving Cars*, Packt Publishing Limited, 2020.
4. K. S. Thyagarajan, *Introduction to Digital Signal Processing Using MATLAB with Application to Digital Communications*, First Edition, Springer International Publishing, 2019.
5. E. Byron, *Radar – Principles, Technology, Applications*, Third Indian Reprint, Pearson Education LPE, 2005.
6. J. Yoshida (Ed.), *Guide to Sensors in Automotive: Making Cars See and Think Ahead*, Aspencore Media, 2020.

26AL751**BATTERY & BATTERY MANAGEMENT SYSTEMS IN EV****3-0-0-3****Course Objectives:**

- To introduce batteries and their parameters
- To introduce the concepts of modelling, charging requirements and battery management system

Course Outcomes

CO01: Understand the principle of battery and battery management system.

CO02: Interpret the concept associated with battery charging / discharging process.

CO03: Familiarize various cell balancing techniques and parameter estimation.

CO04: Design battery model for real-time applications.

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO01			2	2	1	1
CO02			2	2		
CO03			3	3		
CO04	2	2	2	2	2	2

Skills Acquired: Battery management system, Charges

Unit1:

Batteries-Working principle of battery, primary and secondary batteries, battery performance evaluation methods. Cells & Batteries, Nominal voltage and capacity, C rate, Energy and power, series and parallel cell connection, Electrochemistry of Lithium-ion cells – New cell chemistries and trends, Equivalent-circuit models, Physics-based models, Empirical and Physics-based modelling approach. Emerging trends in battery technology.

Unit2:

Introduction to Battery Management System (BMS): Functionality, Battery pack topology, Voltage Sensing, Current Sensing, Temperature Sensing, High-voltage contactor control, Isolation sensing, thermal control, Protection, Communication Interface, Range estimation, State-of-charge estimation, Cell total energy and

cell total power. Voltage-based methods to estimate SoC, Model-based state estimation, Battery Health Estimation, Lithium-ion aging: Negative electrode, Lithium-ion aging: Positive electrode, Cell Balancing, Causes of imbalance, Circuits for balancing and topologies. Cooling of EV battery.

Unit3:

Rechargeable cell, Charging and Discharging Process, Overcharge and Undercharge, Modes of Charging, Charging Standards – CHAdeMO, GB/T, ISO 15118, Discharge models – Drive cycles and impact of auxiliary loads. Battery safety standards – AIS 156, UL 2580 and Homologation Certification Testing. Battery Chargers – On-board and Off-board. Overview of Open Charge Point Protocol (OCPP)- Current EV Charging standards. Vehicle range calculations, Case study- battery packs. Battery dynamics based on life and BMS, Energy balancing with multi-battery system.

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.

26AL752 CONTROL OF POWER CONVERTERS AND ELECTRICAL DRIVES 2-0-2 3

Course Objectives:

- To introduce design of mathematical model of DC and AC machines under transient and steady state conditions
- To impart knowledge on reference frame theory and its application for AC machine analysis
- To demonstrate the open and closed loop controllers for DC and AC Drives
- To provide insight on the control of grid connected converters for automotive applications

Course Outcomes

CO01: Ability to develop mathematical model and analysis of DC and AC Machines for transient and steady state conditions

CO02: Ability to apply reference frame theory to AC machines.

CO03: Ability to analyze the open and closed loop controllers for various types of power converters and DC and AC Drives using scalar and vector controllers.

CO04: Ability to investigate the control of grid connected converters for V2G and G2V

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO01	3	1	3	2	2	1
CO02	3	1	3	1	2	1
CO03	3	2	3	2	2	1
CO04	2	1	3	2	1	1

Skills Acquired: AC machine analysis, Drive control

Unit 1:

Generalized theory of rotating electrical machines – Modeling- Steady state and transient analysis of separately excited DC machines - Control of Brushed DC Motors in EV applications - Analysis with Simulation tools-Trends in EV Motors – Rare Earth free Motors, Axial Motor.

Unit 2:

Transformations in AC machine analysis - Introduction to reference frame theory -Application of reference frame theory to three phase symmetrical induction machines - Modeling – Torque calculation - Steady state and transient analysis of induction machines. Control of Induction Motors - Scalar and Vector control Technique (FOC & DTC) - Introduction to sensor less control - Control for Regeneration mode. Steady state and transient behavior of synchronous machines – Control of Permanent Magnet Synchronous Motors- Review of SPM - IPM concepts v/f control – Vector control - MTPA control- Motor Control Lab - with different types of Motors used in EV (BLDC, AC Induction, PMSM, SRM, SynRM-IPM, EESM,...) along with Motor Control algorithm modeling and practical demonstrations with Torque- Speed and other characteristics.

Unit 3:

Control of Brushless DC motors - Drive operation with inverter - Torque speed curve Machine dynamic model - Drive control - Extended speed operation. Control of Switched Reluctance motors in the context of vehicle power train control. Closed loop control of Grid connected converters for V2G and G2V applications. Analysis with Simulation tools- Motor and Inverter – Homologation testing standard(s) and test cases Functional Safety requirements for Motor Drive Unit.

References

1. P.C.Krause, Analysis of Electric Machines and Drive Systems, Wiley International, 2013.
2. B. Adkins, Generalized Machine Theory, McGraw-Hill, 1964.
3. Ramu Krishnan, Permanent Magnet Synchronous and Brushless DC Motor Drives, CRC Press, 2017
4. T.A.Lipo, Analysis of Synchronous Machines, CRC Press, 2017
5. K T Chau, Electric Vehicle Machines and Drives – Design, Analysis and Application, IEEE Wiley Press, 2015
6. Krishnan, Ramu, Electric Motor Drives: Modeling, Analysis, and Control, Pearson Education India, 2015.
7. Bimal K. Bose, Modern Power Electronics and AC Drives, John Wiley & Sons, 2002.
8. Frede Blaabjerg ed., Control of Power Electronic Converters and Systems, Vol. 1 & 2, Academic Press, 2018.
9. Haitham Abu-Rub, Atif Iqbal and Jaroslaw Guzinski eds., High performance control of AC drives with MATLAB/Simulink models, John Wiley & Sons, 2012.

26AL753 POWER CONVERTERS FOR AUTOMOTIVE APPLICATIONS 2-0-2 3

Course Objectives

- To introduce various power electronic devices, and power converters
- To impart knowledge on design and performance analysis of power converters for automotive applications.
- To demonstrate control of various power converter circuits

Course Outcomes

CO01: Ability to understand various power semiconductor devices, converters and their performance analysis.

CO02: Ability to design various power electronic converters and their auxiliary elements for automotive applications.

CO03: Ability to develop controls for AC-DC, DC-DC and DC-AC converters for automotive applications.

CO04: Ability to evaluate the performance of various power electronic converters.

CO-PO Mapping:

CO-PO	PO1	PO2	PO3	PO4	PO5	PO6
CO01	3	1	3			
CO02	3	2	3	2	2	1
CO03	3	2	3	2	2	1
CO04	3	2	3	3	2	1

Skills Acquired: Power semiconductor devices, Power Converters**Unit 1:**

Overview of power semiconductor devices – I-V and switching characteristics: Power BJT - Thyristors - Power Diodes – MOSFET - IGBT - IGCT - Introduction to Intelligent Power Modules (IPM) and Wide band gap power semiconductor devices (SiC, GaN) - device data sheet Interpretation. Evaluation of Losses in Semiconductor switches - Design of Heat sinks -Snubber circuits and driver circuits. Power Computations for Non-sinusoidal Periodic Waveforms.

Unit 2:

DC/DC converters for automotive applications - Design and analysis of Buck-Boost - PFC - boost, interleaved boost, and bridgeless totem pole, Isolated DC/DC -CLLC, DAB, PSFB, Bi-directional Power converter design and close loop control, High frequency inductor and transformer design.

Unit 3:

DC/AC converters - Voltage source inverters- single and three phase Sinusoidal PWM and Space vector PWM - DC side current of PWM inverter - Current regulated PWM -Introduction to Multilevel inverters - Concept of Grid synchronization - Synchronous reference frame control and Hysteresis control AC-DC converters - Uncontrolled rectifiers - single and three phase – On Board Charger (OBC) with 400V/12V Isolated DCDC Performance parameters. Rectifier and inverter Mode of operation-G2V and V2G operation in EVs . Introduction of EMI, EMC inference and standards. Testing standards and functional safety. Design and Analysis of Power Converters using PSIM/LTSPICE, MATLAB.

References:

1. Emadi, Ali, Advanced Electric Drive Vehicles, CRC Press, 2014.
2. Muhammad H. Rashid, Power Electronics, Circuits, Devices and Applications, Fourth Edition, Pearson, 2014.
3. Randall Shaffer, Fundamentals of Power Electronics with MATLAB, Firewall Media, 2013.
4. Wengang Wayne Bi, Haochung Henry Kuo, Peicheng Ku, and Bo Shen, eds., Handbook of GaN Semiconductor Materials and Devices, CRC Press, 2017.
4. Daniel Hart, Power Electronics, McGraw-Hill, 2011.
5. Ned Mohan, Tore M. Undeland and William P. Robbins, Power Electronics, Converters, Applications and Design, Third Edition, John Wiley and Sons Inc., 2006.
6. John G. Kassakian, Martin F. Schlecht and George C. Verghese, Principles of Power Electronics, Addison Wesley, 1991.
7. Kothari D.P. and Nagrath I.J., “Electric Machines”, Tata McGraw-Hill Publishing Company Limited, New Delhi 2004.
8. Stephen J. Chapman, ‘Electric Machinery Fundamentals’ 4th edition, McGraw Hill Education Pvt. Ltd, 2010.
9. M.G. Say, “Performance and Design of Direct Current Machines”, CBS publishers, New Delhi, 1993.
10. Fitzgerald A.E., Charles Kingsley, Jr. and Stephen D. Umans, “Electric Machinery”, Tata McGraw-Hill Publishing Company Limited 2002.

26AL698**Industry Internship****0-0-2-1****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

CO01: Familiarize with the industry environment/Research Laboratory

CO02: Understand the application of theoretical concepts in a practical setting.

CO03: Prepare technical documents/presentations related to the work completed

CO-PO Mapping:

CO-PO	PO1	PO2	PO3	PO4	PO5	PO6
CO01			3	2	3	3

CO02			3	2	3	3
CO03		3	3	2	3	3

Syllabus:

Students have to undergo practical training/internship in Automotive Electronics industries, automotive OEMs, Tier-1 suppliers, EV industries, or relevant research laboratories of their choice with the approval of the department. At the end of the training, the student shall submit a detailed training report along with the certificate of completion to the department in the prescribed format.

26AL798**Dissertation Phase I****0-0-30-10****Course Objectives**

- To enhance students' ability to conduct independent research, including literature review, data collection, and analysis.
- To foster critical analysis of existing literature and methodologies in the chosen field of study.
- To gain proficiency in selecting appropriate research methods and techniques for addressing research questions.

Course Outcomes

CO01: Ability to define a research problem.

CO02: Ability to apply engineering concepts to the research problem.

CO03: Ability to design and conduct independent research in the domain of interest.

CO04: Ability to evaluate and analyze the outcomes of the research.

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO01	3	3	3	3	3	3
CO02	3	3	3	3	3	3
CO03	3	3	3	3	3	3
CO04	3	3	3	3	3	3

Contents:

Problems and concepts may be defined based on extensive literature survey by standard research articles. Significance of proposed problem and the state-of-the-art to be explored. Industry relevant tools may be used for demonstrating the results with physical meaning and create necessary research components. Publications in reputed journals /conferences may be considered for authenticating the results. Prepare and submit a detailed technical report. Provide a presentation and defend the dissertation work carried out.

26AL799**Dissertation Phase II****0-0-45-15****Course Objectives**

- To implement and validate the proposed research methodology/solution for the identified research problem.
- To enhance students' ability to perform experimental analysis, interpretation of results, and performance evaluation.
- To develop skills in technical documentation, research publication, and presentation of research outcomes.
- To foster innovation, critical thinking, and professional research practices in the chosen domain of study.

Course Outcomes

CO01: Ability to implement and validate the proposed research methodology/system.

CO02: Ability to conduct experiments, analyze results, and interpret research findings effectively.

CO03 :Ability to demonstrate innovation and problem-solving skills in the selected research domain.

CO04 :Ability to prepare technical reports, research publications, and effectively present the research outcomes.

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO01	3	3	3	3	3	3
CO02	3	3	3	3	3	3
CO03	3	3	3	3	3	3
CO04	3	3	3	3	3	3

Contents:

Problems and concepts may be defined based on extensive literature survey by standard research articles. Significance of proposed problem and the state-of the art to be explored. Industry relevant tools may be used for demonstrating the results with physical meaning and create necessary research components. Publications in reputed journals /conferences may be considered for authenticating the results. Prepare and submit a detailed technical report. Provide a presentation and defend the dissertation work carried out.

25AVP501

Mastery Over Mind (MAOM)

1-0-2 2

Course Outcomes

CO01: Relate to the causes of stress in one's life.

CO02: Experiment with a range of relaxation techniques

CO03: Model a meditative approach to work, study, and life.

CO04: Develop appropriate practice of MA-OM technique that is effective in one's life

CO05: Inculcate a higher level of awareness and focus.

CO06: Evaluate the impact of a meditation technique

1. Course Overview

Master Over the Mind (MAOM) is an Amrita initiative to implement schemes and organise 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 gives an introduction to 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.

2. Course Syllabus

Unit 1 (4 hours)

Causes of Stress: The problem of not being relaxed. Need for meditation -basics of stress management at home and workplace. Traditions and Culture. Principles of meditation– promote a sense of control and autonomy in the Universal Human Value System. Different stages of Meditation. Various Meditation Models. Various practices of Meditation techniques in different schools of philosophy and Indian Knowledge System.

Unit 2 (4 hours)

Improving work and study performance. Meditation in daily life. Cultivating compassion and good mental health with an attitude of openness and acceptance. Research and Science of Meditation: Significance of

practising meditation and perspectives from diverse fields like science, medicine, technology, philosophy, culture, arts, management, sports, economics, healthcare, environment etc. The role of meditation for stress and anxiety reduction in one's life with insights based on recent cutting-edge technology. The effect of practicing meditation for the wholesome wellbeing of an individual.

Unit 3 (4 hours)

Communications: principles of conscious communication. Relationships and empathy: meditative approach in managing and maintaining better relationships in life during the interactions in the world, role of MAOM in developing compassion, empathy and responsibility, instilling interest, and orientation to humanitarian projects as a key to harness intelligence and compassion in youth. Methodologies to evaluate effective awareness and relaxation gained from meditation. Evaluating the global transformation through meditation by instilling human values which leads to service learning and compassion driven research.

TEXT BOOKS:

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.

REFERENCES:

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

23HU601

Career Competency I

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:

CO01: Soft Skills - To develop positive mindset, communicate professionally, manage time effectively and set personal goals and achieve them.

CO02: Soft Skills - To make formal and informal presentations with self-confidence.

CO03: Aptitude - To analyze, understand and employ the most suitable methods to solve questions on arithmetic and algebra.

CO04: 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

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO01	2	1				
CO02	2	1				
CO03	2	1				
CO04	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

23HU611**Career Competency II****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:

CO01: Soft Skills - To demonstrate good interpersonal skills, solve problems and effectively participate in group discussions.

CO02: Soft Skills - To write technical resume and perform effectively in interviews.

CO03: Aptitude - To identify, investigate and arrive at appropriate strategies to solve questions on arithmetic by managing time effectively.

CO04: Aptitude - To investigate, understand and use appropriate techniques to solve questions on logical reasoning and data analysis by managing time effectively.

CO05: 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

CO06: 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

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO01	2	1				
CO02	2	1				
CO03	2	1				
CO04	2	1				

CO5	1	2				
CO6	2	2				

Syllabus**Soft Skills**

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

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

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

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

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

Verbal

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

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

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

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

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

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

Aptitude

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

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

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

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

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

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

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

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

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

References**Soft Skills**

Team Building

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

Verbal

- "GMAT Official Guide" by the Graduate Management Admission Council, 2019
- Arun Sharma, "How to Prepare for Verbal Ability And Reading Comprehension For CAT"
- Joern Meissner, "Turbocharge Your GMAT Sentence Correction Study Guide", 2012
- Kaplan, "Kaplan GMAT 2012 & 13"
- Kaplan, "New GMAT Premier", Kaplan Publishing, U.K., 2013
- Manhattan Prep, "Critical Reasoning 6th Edition GMAT"
- Manhattan Prep, "Sentence Correction 6th Edition GMAT"
- Mike Barrett "SAT Prep Black Book The Most Effective SAT Strategies Ever Published"
- Mike Bryon, "Verbal Reasoning Test Workbook Unbeatable Practice for Verbal Ability, English Usage and Interpretation and Judgement Tests"
- www.bristol.ac.uk/arts/skills/grammar/grammar_tutorial/page_55.htm
- www.campusgate.co.in

Aptitude

- Arun Sharma, "How to Prepare for Quantitative Aptitude for the CAT Common Admission Test", Tata Mc Graw Hills, 5th Edition, 2012
- 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
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- www.campusgate.co.in
- www.careerbless.com

26CUL500	INTEGRATED AMRITA MEDITATION TECHNIQUE	L-T-P-C 0-0-2-1
A. Nature of Course: Lab/Practical		
B. Course Description: The course introduces students to the Integrated Amrita Meditation Technique (IAM 20), a structured practice that combines yogic stretches, regulated breathing (pranayama), and guided meditation. The course integrates both theoretical understanding and experiential practice to enhance emotional balance, stress resilience, concentration, and overall holistic development.		

Aligned with United Nations Sustainable Development Goal 3 (SDG 3): Good Health and Well-Being, the course promotes preventive mental health care, emotional well-being, and sustainable lifestyle practices among students. By fostering inner stability, self-awareness, and self-regulation, the programme supports academic excellence and contributes to the development of healthy individuals and communities.

The course is expected to improve student well-being, enhance academic focus and cognitive clarity, reduce stress-related indicators, and promote compassionate and emotionally supportive culture.

C. Course Objectives:

- To promote overall health and well-being of students.
- To train students in the structured practice of IAM 20.
- To develop emotional regulation and stress management skills.
- To encourage reflective awareness and compassionate living.

D. Course Outcomes:

After successful completion of the course, students will be able to:

CO	Course Outcomes	Knowledge Level (Bloom's Taxonomy)
CO1	Explain principles and components of IAM 20	Understand (L2)
CO2	Demonstrate and correct meditation practice independently	Apply (L3)
CO3	Analyze personal stress patterns using meditation insights	Analyse (L4)
CO4	Evaluate personal growth through daily practice	Evaluate (L5)

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

CO's	Program Outcomes (PO's)											Program Specific Outcomes (PSF's)		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO1	-	-	-	-	-	1	-	2	-	-	1	-	-	-
CO2	-	-	-	-	-	2	2	1	1	-	1	-	-	-
CO3	-	-	-	-	-	1	1	2	-	-	1	-	-	-
CO4	-	-	-	-	-	1	1	1	1	-	1	-	-	-

F. Syllabus

Unit 1: Foundations of Meditation (CO1)

- Meaning and purpose of meditation
- Demonstration and supervised training
- Overview of structure of IAM
- Guidance for safe and effective practice
- Importance of mental health

Unit 2: Theoretical Foundations (CO2)

- Structure and components of IAM: yogic stretches, regulated breathing, and guided meditation
- Breath–mind connection
- Integration of IAM practice into daily routine and academic life
- Application of IAM for stress management, concentration, and holistic student development

Unit 3: IAM Practical Training (CO3)

- Preparatory stretches
- Pranayama components
- Guided meditation sequence
- Corrections and common challenges

Unit 4: Integration and Transformation (CO4)

- Building daily discipline
- Research evidence in higher education
- Compassion and mindful communication

G. Evaluation Pattern:

Assessment	Internal (60)	External (40)
Attendance	20 Marks	
Class Participation	20 Marks	
Activity	20 Marks	
Practical Demonstration		30 Marks
Viva		10 Marks

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Introduction: Love is the substratum of life and spirituality. If love is absent life becomes meaningless. In the present world if love is used as the string to connect the beads of values, life becomes precious, rare and beautiful like a fragrant blossom. Values are not to be learned alone. They have to be imbibed into the inner spirit and put into practice. This should happen at the right time when you have vitality and strength, when your hearts are open.

The present course in value education is a humble experience-based effort to lead and metamorphosis the students through the process of transformation of their inner self towards achieving the best. Amma's nectarous words of wisdom and acts of love are our guiding principles. Amma's philosophy provides an insight into the vision of our optimistic future.

1. Invocation, Satsang and Question - Answers
2. Values - What are they? Definition, Guiding Principles with examples Sharing own experiences
3. Values - Key to meaningful life. Values in different contexts
4. Personality - Mind, Soul and Consciousness - Q and A. Body-Mind-Intellect and the Inner psyche Experience sharing
5. Psychological Significance of samskara (with e.g. From Epics)
6. Indian Heritage and Contribution and Q and A; Indian Ethos and Culture
7. Self-Discipline (Evolution and Practice) – Q and A
8. Human Development and Spiritual Growth - Q and A
9. Purpose of Life plus Q and A
10. Cultivating self-development
11. Self-effort and Divine Grace - their roles – Q and A; - Vedanta and Creation –Understanding a spiritual Master
12. Dimensions of Spiritual Education; Need for change Lecture – 1; Need for Perfection Lecture - 2
13. How to help others who have achieved less - Man and Nature Q and A, Sharing of experiences

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3. Swami Ramakrishnanda Puri - Rising Along the Razor's Edge
4. Deepak Chopra - Book 1: Quantum Healing; Book 2: Alpha and Omega of God; Book 3: Seven Spiritual Rules for Success
5. Dr. A. P. J. Abdul Kalam- 1. Ignited Minds 2. Talks (CD)
6. Swami Ramakrishnanda Puri - Ultimate Success
7. Swami Jnanamritananda Puri - Upadesamritham (Trans: Malayalam)
8. Vedanta Kesari Publication - Values - Key to a meaningful life
9. Swami Ranganathananda - Eternal values for a changing society
10. David Megginson & Vivien Whitaker - Cultivating Self Development
11. Elizabeth B. Hurlock - Personality Development, Tata McGraw Hill
12. Swami Jagatatananda - Learn to Live (Vol.1 and 2), RK Ashram, Myslapore