Master of Technology

in

Automotive Electronics

Curriculum & Syllabi 2024

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, Sofware 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	Teaching Schemes			Credits
			L	T	P	
FC	24AL601	Data Science for Automotive Applications	3	0	0	3
FC	24AL602	Automotive Systems	3	0	2	4
FC	24AL603	E/E Architecture	3	0	0	3
SC	24AL604	Embedded Systems Design	3	0	0	3
SC	24AL605	Electric Vehicles	3	0	0	3
SC	24AL606	Automotive Control Systems	3	0	0	3
FC	24AL681	Data Science Lab	0	0	4	2
SC	24AL682	Embedded Systems Lab	0	0	4	2
HU	23AVP601	Amrita Value Program				P/F
HU	23HU601	Career Competency - I	0	0	3	P/F
HU	22AVP103	Mastery Over Mind (MAOM)	1	0	2	2
		Total	**18**	**0**	**15**	**25**

Semester – II

Type	Code	Course Name	Teaching Schemes			Credits
			L	T	P	
SC	24AL611	Advanced Embedded Systems	3	0	0	3
SC	24AL612	Automotive Systems Engineering & Safety	3	0	0	3
SC	24RM608	Research Methodology	3	0	0	3
E		Elective - 1	3	0	0	3
E		Elective - 2	3	0	0	3
E		Elective - 3	3	0	0	3
SC	24AL683	Advanced Embedded Systems Lab	0	0	4	2
SC	24AL684	Systems Engineering Lab	0	0	4	2
HU	23HU611	Career Competency – II	0	0	3	1
	24AL690*	Live-in-Lab*	0	0	9	3*
		Total	**18**	**0**	**10**	**23/26**

*Optional - Students undertaking and registering for a Live-in-Labs project, can be exempted from registering for an Elective course in the higher semester.

Semester – III

Type	Code	Course Name	Teaching Schemes			Credits
			L	T	P	
E		Open Elective - 1**	3	0	0	3
E		Open Elective - 2**	3	0	0	3
P	24AL798	Dissertation Phase – I	0	0	24	12
		Total	**6**	**0**	**24**	**18/15**

**Open Elective – Online NPTEL based course approved by the Department.

Semester – IV

Type	Code	Course Name	Teaching Schemes			Credits
			L	T	P	
P	24AL799	Dissertation Phase – II	0	0	24	12
		Total	**0**	**0**	**24**	**12**

Evaluation pattern for the all the courses will be as per the Institute policy.

Total Credits: 78

Electives

Domain – Software Defined Vehicles

Type	Code	Course Name	Teaching Schemes			Credits
			L	T	P	
E	24AL731	Advanced Communication Systems	3	0	0	3
E	24AL732	Software Defined Vehicles	3	0	0	3
E	24AL733	Connected Vehicles and Security	3	0	0	3

Domain – Advanced Driver Assistance Systems (ADAS)

Type	Code	Course Name	Teaching Schemes			Credits
			L	T	P	
E	24AL741	Deep Learning and Applications	3	0	0	3
E	24AL742	Perception and Control for Autonomous Driving	3	0	0	3
E	24AL743	Sensing for Autonomous Vehicles	3	0	0	3

Domain – Electrification

Type	Code	Course Name	Teaching Schemes			Credits
			L	T	P	
E	24AL751	Battery and Battery Management Systems in EV	3	0	0	3
E	24AL752	Control of Power Controllers and Electrical Drives	2	0	2	3
E	24AL753	Power Converters for Automotive Applications	2	0	2	3

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24AL601 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.

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24AL602 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	PO 1	PO 2	PO 3	PO 4	PO 5	PO6
CO 1	2	2	3			
CO 2	2	2	3			
CO 3	2	2	3			
CO4	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 – 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

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24AL603 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

Contents

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, Protobuff, 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 Grzemba, *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

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24AL604 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 (CO)

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	PO 1	PO 2	PO 3	PO 4	PO 5	PO6
CO 1	2		2		3	
CO 2	2		2		3	
CO 3	2		2		3	2
CO4	2		2		3	2

Skills acquired: STM32 Microcontroller, Peripheral interfacing, Design requirements

Contents

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.

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24AL605 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 (CO)

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	PO 1	PO 2	PO 3	PO 4	PO 5
CO 1	2	-	3	-	3
CO 2	2	-	3	-	-
CO 3	2	-	3	-	2
CO4	2	-	3	2	2

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

Contents

Unit 1:

Electric vehicles (EVs) - advantages and impacts - EV market and promotion - Infrastructure - International Regulation and standards – Power quality ratings - Standardization - 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 architectures and subsystems – Regenerative braking-Motors-Motor Sizing- Power converters, Inverters and motor control - 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 - Integration of EV subsystems- EV Chargers - On-board 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.

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24AL606 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 (CO)

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	PO 1	PO 2	PO 3	PO 4	PO 5
CO 1	2	-	3	-	3
CO 2	2	-	-	2	-
CO 3	2	-	2	2	2
CO4	2	-	3	3	3

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

Contents

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 (Kalman filter). for– Lane keep assist system, Autonomous steering system

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.

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24AL681 Data Science Lab 0-0-4-2

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

Contents - 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.

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24AL682 Embedded Systems Lab 0-0-4-2

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 (CO)

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		2		3	
CO02	2		2		3	
CO03	2		2		3	2
CO04	2		2		3	2

Contents:

List of experiments for Embedded Programming Lab

1. Toggle Green LED (LD2) on Nucleo64 board at 1 Hz , using BSRR & SWITCH
2. USART / UART Transmit & Receive
3. Interrupt handling – GPIO, UART
4. Toggle user LED at 5 Hz using the 'SysTick' Counter
5. Toggle the LED at 1 Hz using TIM2
6. Generating Waveform Output Using Compare Mode
7. Using ADC to convert an input channel
8. Using 32-bit TIM2 for PWM Output
9. Transmit / Receive via CAN

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24AL611 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)

Course Outcomes:

CO1: understand the concepts of multi-core processor system
CO2: apply advanced peripheral programming techniques
CO3: analyze task handling and its real time scheduling
CO4: implement programming models using GPU

CO-PO Mapping:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO6
CO 1	2		3		3	
CO 2	2		3		3	
CO 3	2		3		3	2
CO 4	2		3		3	3

Skills Acquired: Configuration of peripherals of an advanced processor, CUDA programming using GPU, RTOS & IPC

Contents

Unit 1:

Need for Multicore processors - 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 GPIO Control – UART DMA – ADC Group Scan – Interrupt Programming – Overview of Renasas R-Car

Unit 2:

Concepts of RTOS: 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, Pipes, Timer Management.

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 (registers, shared memory, global memory) - CUDA C++ programming: vector addition - Kernels - Thread Hierarchy - Thread Block Clusters - Memory Hierarchy - Heterogeneous Programming - Asynchronous SIMT Programming Model - Execution Environment and Memory Model - Programming Interface - Allocating Physical Memory - Virtual Aliasing Support

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*, NVDIA, 2024

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24AL612 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 (CO):

CO1 Ability to understand salient concepts in automotive systems engineering
CO2 Ability to analyze and process model-based systems engineering
CO3 Ability to design and implement data driven systems engineering
CO4 Ability to understand safety standards applied to vehicular system development

CO-PO Mapping:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	3		2			
CO 2	3		2		2	
CO 3	3		2		2	3
CO 4	3		2		2	2

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

Contents:

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 – Examples based on Vehicle domains: Chassis Control, Infotainment, Engine Control, ADAS

Unit 2
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. Examples of safety critical systems.

Unit 3
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 – Co-simulation with Plant models

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. William M. Goble, "Control Systems Safety Evaluation and Reliability", 3, pp. 458, International Society of Automation, 2010.

6. Julian Weber, "Automotive Development Processes", 1(12), pp. 312, Springer-Verlag Berlin Heidelberg, 2009.
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.

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24AL683 Advanced Embedded Systems Lab 0-0-4-2

Course Objectives

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

Course Outcomes:

CO1: understand the configuration of peripherals in an advanced microcontroller
CO2: apply multicore programming techniques
CO3: analyze utilization of GPU resources
CO4: implement CUDA programs in GPU hardware

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

CO-PO Mapping:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO6
CO 1	2	3	3		3	
CO 2	2	3	3		3	
CO 3	2	3	3		3	2
CO 4	2	3	3		3	3

Contents:

Lab Experiments

1. Control of LED using Multicore
2. Data Transfer from UART through DMA
3. Group Scan using ADC
4. Fault Signaling Protocol implementation using Safety Management Unit
5. CPU Trap recognition and handling
6. Vector addition using CUDA
7. Image Scaling using Texture Memory
8. CUDA Thread Programming
9. CUDA CPU Occupancy Analysis
10. Legacy code conversion to multicore environment
11. Parallel reduction implementation using CUDA

*Note: Experiment 1,2 & 3 to be handled using interrupts

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24AL684 System Engineering Lab 0-0-4-2

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 (CO):

CO1 Ability to understand salient concepts in automotive systems engineering
CO2 Ability to analyze and process model-based systems engineering
CO3 Ability to design and implement model-based systems engineering
CO4 Ability to apply prevalent safety standards in vehicular system development

CO-PO Mapping:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	3	3	2			
CO 2	3	3	2		2	
CO 3	3	3	2		2	3
CO 4	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
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.

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24AL731 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:

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

CO1: understand the concepts of in-vehicle communication
CO2: understand the automotive environment and its challenges
CO3: analyze the usage of middleware in automotive domain
CO4: understand the concepts of Data Distribution Service (DDS) and Protocol Buffers

Skills Acquired: Understanding of advanced vehicular communication technologies like, Automotive Ethernet, DDS and Protocol Buffers

CO-PO Mapping:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO6
CO 1	2		2	3	3	
CO 2	2		2	3	3	
CO 3	2		2	3	3	2
CO 4	2		2	3	3	2

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

Contents

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

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24AL732 Software Defined Vehicles 3-0-0-3

Course Objectives

- To introduce Software Defined Vehicle fundamentals and service-oriented protocols such as SOME/IP
- To impart knowledge on middleware based on Adaptive AUTOSAR
- To provide insights on Virtualization, Hypervisor and Containers

Course Outcomes (CO)

CO01: Ability to understand software defined vehicle architecture in terms of hardware and software.
CO02: Ability to define Adaptive AUTOSAR based software
CO03: Ability to understand virtualization techniques
CO04: Ability to understand containerization techniques

CO-PO Mapping

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	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: SDV Understanding and next generation software architecture realization with Adaptive AUTOSAR.

Contents

Unit.1: (15 Hours)
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: (15 Hours)
AUTOSAR Overview – Evolution of AUTOSAR – Introduction to Adaptive AUTOSAR – Adaptive AUTOSAR architecture - Communication Management – Lifecycle Management – Update and Configuration Management – Linux & Qemu Basics - Adaptive Application and Platform realization examples

Unit.3: (15 Hours)
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. James Larminie and John Lowry , "Electric Vehicle Technology Explained", Willey, 2012.
3. Thomas D. Nadeau and Ken Gray, "Software-Defined Networking" , O'Reilly Media, 2013.

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24AL733 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:

By the end of this course, students will be able to:

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	PO 1	PO 2	PO 3	PO 4	PO 5	PO6
CO 1	2		2	3	3	
CO 2	2		2	3	3	
CO 3	2		2	3	3	2
CO 4	2		2	3	3	2

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

Contents:

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 Schäuffele, 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.

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24AL741 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 (CO)

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	PO 1	PO 2	PO 3	PO 4	PO 5	PO6
CO 1	2		2	3	3	
CO 2	2		2	3	3	2
CO 3	2		2	3	3	3
CO4	2		2	3	3	3

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

Contents

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 - Markov Decision Processes (MDP) - 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.

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24AL742 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:

At the end of the course, the student should be able to
CO1: implement data fusion and path planning algorithms for autonomous vehicles.
CO2: implement vehicle dynamics modeling and control using PI-PID, AI-based methods
CO3: development data-driven systems, data collection to CI/CD
CO4: create systems for real-world challenges in autonomous driving

CO-PO Mapping:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO6
CO 1	2		2	3	3	
CO 2	2		2	3	3	
CO 3	2		2	3	3	3
CO 4	2		2	3	3	3

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

Contents:

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.

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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.

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24AL743 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 (CO)
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	PO 1	PO 2	PO 3	PO 4	PO 5	PO6
CO 1	2		2	3	3	
CO 2	2		2	3	3	
CO 3	2		2	3	3	3
CO 4	2		2	3	3	3

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

Contents
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

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

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

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.

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24AL751 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

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

CO-PO Mapping

CO-PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1			2	2	1	1
CO2			2	2		
CO3			3	3		
CO4	2	2	2	2	2	2

Skills Acquired: Battery management system, Charges

Contents

Unit 1

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, Equivalent-circuit models, Physics-based models, Empirical and Physics-based modelling approach. Emerging trends in battery technology.

Unit 2

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.

Unit 3

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 Chargers – On-board and Off-board. Overview of Open Charge Point Protocol (OCPP). 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.

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24AL752 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

CO1: Ability to develop mathematical model and analysis of DC and AC Machines for transient and steady state conditions
CO2 Ability to apply reference frame theory to AC machines.
CO3 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.
CO4 Ability to investigate the control of grid connected converters for V2G and G2V

CO-PO Mapping

CO-PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	3	2	2	1
CO2	3	1	3	1	2	1
CO3	3	2	3	2	2	1
CO4	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 - Open and closed loop control of chopper fed DC motors - Analysis with Simulation tools.

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.

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.

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.

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24AL753 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:

CO1 Ability to understand various power semiconductor devices, converters and their performance analysis.
CO2 Ability to design various power electronic converters and their auxiliary elements for automotive applications.
CO3 Ability to develop controls for AC-DC, DC-DC and DC-AC converters for automotive applications.
CO4 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 - 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 - Four quadrant dc- dc converter - Converter Topologies for EV Auxiliary Power Modules - fly-back - forward - push-pull - Full bridge - bidirectional DC-DC converters for EV charging applications.
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 - Performance parameters. Rectifier and inverter Mode of operation-G2V and V2G operation in EVs .
Introduction of EMI, EMC inference and standards.
Design and Analysis of Power Converters using PSIM/LTSPICE, MATLAB. Introduction to cost analysis.

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.
5. Daniel Hart, Power Electronics, McGraw-Hill, 2011.
6. Ned Mohan, Tore M. Undeland and William P.Robbins, Power Electronics, Converters, Applications and Design, Third Edition, John Wiley and Sons Inc., 2006.
7. John G. Kassakian, Martin F.Schlecht and George C.Verghese, Principles of Power Electronics, Addison Wesley, 1991.
8. Kothari D.P. and Nagrath I.J., “Electric Machines”, Tata McGraw-Hill Publishing Company Limited, New Delhi 2004.
9. Stephen J. Chapman, ‘Electric Machinery Fundamentals’4th edition, McGraw Hill Education Pvt. Ltd, 2010. References:
10. M.G. Say, “Performance and Design of Direct Current Machines”, CBS publishers, New Delhi, 1993.
11. Fitzgerald A.E., Charles Kingsley, Jr. and Stephen D. Umans, “Electric Machinery”, Tata McGraw-Hill Publishing Company Limited 2002.

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24AL798 Dissertation Phase I 0-0-24-12

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 (CO)
CO1 Ability to define a research problem.
CO2 Ability to apply engineering concepts to the research problem.
CO3 Ability to design and conduct independent research in the domain of interest.
CO4 Ability to evaluate and analyze the outcomes of the research.

CO-PO Mapping:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO6
CO 1	2	3	3	2	3	3
CO 2	2	3	3	2	3	3
CO 3	2	3	3	2	3	3
CO 4	2	3	3	2	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.

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24AL799 Dissertation Phase II 0-0-24-12

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 (CO)
CO1 Ability to define a research problem.
CO2 Ability to apply engineering concepts to the research problem.
CO3 Ability to design and conduct independent research in the domain of interest.
CO4 Ability to evaluate and analyze the outcomes of the research.

CO-PO Mapping:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO6
CO 1	2	3	3	2	3	3
CO 2	2	3	3	2	3	3
CO 3	2	3	3	2	3	3
CO 4	2	3	3	2	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.

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24RM608 Research Methodology 3-0-0-3

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)
CO1 Ability to understand some basic concepts of research and its methodologies.
CO2 Ability to define and apply appropriate parameters and research problems.
CO3 Ability to develop skills to draft a research paper.
CO4 Ability to analyse and comprehend the ethical practices in conducting research and dissemination of results in different forms.

CO-PO Mapping:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO6
CO 1	2	3	3	2	3	3
CO 2	2	3	3	2	3	3
CO 3	2	3	3	2	3	3
CO 4	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. Bordens, K. S. and Abbott, B. B., Research Design and Methods – A Process Approach, 8th Edition, McGraw-Hill, 2011.
2. C. R. Kothari, Research Methodology – Methods and Techniques, 2nd Edition, New Age International Publishers.
3. Davis, M., Davis K., and Dunagan M., Scientific Papers and Presentations, 3rdEdition, 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

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22AVP103 Mastery Over Mind (MAOM) 1-0-2 2

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.

3. Evaluation and Grading

Internal			External	Total
Components	Weightage		Practical (attendance and class participation) 60%	100%
Quizzes(based on the reading material)	20%	40%		
Assignments (Based on webinars and lecture series)	20%			

4. Course Outcomes (CO)

CO1: Relate to the causes of stress in one's life.
CO2: Experiment with a range of relaxation techniques
CO3: Model a meditative approach to work, study, and life.
CO4: Develop appropriate practice of MA-OM technique that is effective in one's life
CO5: Inculcate a higher level of awareness and focus.
CO6: Evaluate the impact of a meditation technique

***Program Outcomes (PO) (As given by NBA and ABET)**

PO1: Engineering Knowledge
PO2: Problem Analysis
PO3: Design/Development of Solutions
PO4: Conduct Investigations of complex problems
PO5: Modern tools usage
PO6: Engineer and Society
PO7: Environment and Sustainability
PO8: Ethics
PO9: Individual & Team work
PO10: Communication
PO11: Project management & Finance
PO12: Lifelong learning

CO – PO Affinity Map

P O/ C O	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PS0 1	PSO 2	PSO 3
CO 1	3	3	3	2		-	2	3	-	3	-	3	-	-	-
CO 2	3	3	3	2	2	_	2	3	3	3	-	3	-	-	-
CO 3	3	3	2	2	2	2	2	3	3	3	-	3	-	-	-
CO 4	3	3	3	2	-	2	3	3	3	3	-	3	-	-	-
CO 5	3	2	2	2	-	2	-	3	2	2	-	2	-	-	-
CO 6	3	2	2	2	3	2	_	3	2	2	-	2	-	-	-

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

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

Course Objectives:

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

Course Outcomes:

CO1: Soft Skills - To develop positive mindset, communicate professionally, manage time effectively and set personal goals and achieve them.
CO2: Soft Skills - To make formal and informal presentations with self-confidence.
CO3: Aptitude - To analyze, understand and employ the most suitable methods to solve questions on arithmetic and algebra.
CO4: Aptitude - To analyze, understand and apply suitable techniques to solve questions on logical reasoning and data analysis.
CO5: Verbal - To infer the meaning of words and use them in the right context. To have a better understanding of the nuances of English grammar and become capable of applying them effectively.
CO6: Verbal - To identify the relationship between words using reasoning skills. To understand and analyze arguments and use inductive/deductive reasoning to arrive at conclusions and communicate ideas/perspectives convincingly.

CO-PO Mapping

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

Syllabus:

Soft Skills

Introduction to 'campus to corporate transition':
Communication and listening skills: communication process, barriers to communication, verbal and non-verbal communications, elements of effective communication, listening skills, empathetic listening, role of perception in communication.
Assertiveness skills: the concept, assertiveness and self-esteem, advantages of being assertive, assertiveness and organizational effectiveness.
Self-perception and self-confidence: locus of control (internal v/s external), person perception, social perception, attribution theories-self presentation and impression management, the concept of self and self-confidence, how to develop self-confidence.
Goal setting: the concept, personal values and personal goals, goal setting theory, six areas of goal setting, process of goal setting: SMART goals, how to set personal goals
Time management: the value of time, setting goals/ planning and prioritizing, check the time killing habits, procrastination, tools for time management, rules for time management, strategies for effective time management

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

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

Verbal

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

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

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

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

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

Aptitude

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

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

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

Averages: Basics, and Weighted Average.

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

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

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

Data Interpretation: Tables, Bar Diagrams, Line Graphs, Pie Charts, Caselets, Mixed Varieties, and other forms of data representation.

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

Logarithms, Inequalities and Modulus: Basics

References

Soft Skills:

Communication and listening skills:

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

Assertiveness skills:

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

Self-perception and self-confidence:

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

Time management:

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

Verbal:

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

Aptitude:

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

Evaluation Pattern

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

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

23HU611	**Career Competency II**	**L-T-P-C: 0-0-3-1**

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

Course Objectives:

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

Course Outcomes:

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

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

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

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

C05: Verbal - To be able to use diction that is more refined and appropriate and to be competent in knowledge of grammar to correct/improve sentences

C06: Verbal - To be able to examine, interpret and investigate passages and to be able to generate ideas, structure them logically and express them in a style that is comprehensible to the audience/recipient.

CO-PO Mapping

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

Syllabus

Soft Skills

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

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

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

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

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

Verbal

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

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

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

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

Public Speaking Skills: Empower students to overcome glossophobia and speak effectively and confidently

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

Aptitude
Sequence and Series: Basics, AP, GP, HP, and Special Series.
Geometry: 2D, 3D, Coordinate Geometry, and Heights & Distance.
Permutations & Combinations: Basics, Fundamental Counting Principle, Circular Arrangements, and Derangements.
Probability: Basics, Addition & Multiplication Theorems, Conditional Probability and Bayes' Theorem.
Logical Reasoning I: Arrangements, Sequencing, Scheduling, Venn Diagram, Network Diagrams, Binary Logic, and Logical Connectives, Clocks, Calendars, Cubes, Non-Verbal reasoning and Symbol based reasoning.
Logical Reasoning II: Blood Relations, Direction Test, Syllogisms, Series, Odd man out, Coding & Decoding, Cryptarithmetic Problems and Input - Output Reasoning.
Data Sufficiency: Introduction, 5 Options Data Sufficiency and 4 Options Data Sufficiency.
Campus recruitment papers: Discussion of previous year question papers of all major recruiters of Amrita Vishwa Vidyapeetham.
Miscellaneous: Interview Puzzles, Calculation Techniques and Time Management Strategies.

References
Soft Skills
Team Building

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

Verbal

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

Aptitude

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