M.TECH. AUTOMOTIVE ELECTRONICS

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

India is becoming a premier Automobile hub of the world, with all the automobile giants having a presence in India. The quality and skills of the automotive engineers being developed needs to be sharpened in order to satisfy the stringent requirements of the Automobile industry. The M.Tech. Programme in Automotive Electronics of the Amrita School of Engineering, is focused more on the design of modern electronic hardware systems for automotive applications. Emphasis is placed on a creative and imaginative approach to automotive electronics system design.

The Objectives of this Programme is;

1. To provide a thorough understanding of the automotive systems, vehicle dynamics, electrical and electronic systems (Embedded Systems) used in automobiles.
2. To develop the ability to analyze, simulate, design and verify electronic systems for controlling mechanical systems in automobiles.
3. To develop the ability to test and validate automotive electronic systems using modern software/ hardware tools.
4. To conceptualize automotive electronic technologies for future.

In addition to the core courses (Foundation Core and Subject Core), a rich set of electives are included in the curriculum, to help the students to enhance their knowledge base in the area of automotive electronics. The Open Labs, an integral part of the curriculum, will see the students design and prototype an automotive sub-system, which is used exclusively in the Body Electronics/ Chassis Control/ Power train/ Navigation domains of Automotive Electronics. Additionally, most of the courses offered in the curriculum will be supported by a standard learning tool (Software/ Hardware) accepted by the scientific community. This Learning-by-Doing philosophy, envisioned by the university will add value to the program, so that the students are equipped to face the real world challenges of the Automotive Industry of the future.

CURRICULUM

First Semester

Course Code	Type	Course	L–T–P	Cr
17AL 601	FC	Linear Algebra and Optimization for Signal Processing	3–0–0	3
17AL 602	FC	Automotive Embedded Systems	3–0–1	4
17AL 603	FC	Digital Control Systems	3–0–0	3
17AL 610	SC	Principles of Automotive Systems	3–0–0	3
17AL 611	SC	Automotive Grade Processors	3–0–1	4
17AL 614	SC	Automotive Laboratory-I	0-0-1	1
17HU 601	HU	Cultural Education*		P/F
			Total Credits	18

* Non-credit course

Second Semester

Course Code	Type	Course	L–T–P	Cr
17AL 612	SC	Vehicle Dynamics and Control	3-0-1	4
17AL 613	SC	Electric Vehicles and Architectures	3–0–0	3
17AL 604	FC	RTOS in Multi-core Environment	3–0–1	4
17AL 605	FC	Deep Learning	3–0–0	3
	E	Elective – I	3–0–0	3
17AL 615	SC	Automotive Laboratory-II	0–0–1	1
17EN 600	HU	Technical Writing*		P/F
			Total Credits	18

* Non-credit course

Third Semester

Course Code	Type	Course	L–T–P	Cr
	E	Elective – II	3–0–0	3
	E	Elective – III	3–0–0	3
17AL 616	SC	Automotive Electronics Laboratory (OPEN LAB)	0–0–1	1
17AL 797	P	Research Methodology	1-0-0	1
17AL 798	P	Dissertation		8
			Total Credits	16

Fourth Semester

Course Code	Type	Course	L–T–P	Cr
17AL 799	P	Dissertation		14
			Total Credits	14

TOTAL CREDITS: 66

LIST OF COURSES

Foundation Core

Course Code	Course	L–T–P	Cr
17AL 601	Linear Algebra and Optimization for Signal Processing	3–0–0	3
17AL 602	Automotive Embedded Systems	3–0–1	4
17AL 603	Digital Control Systems	3–0–0	3
17AL 604	RTOS in Multi-core Environment	3–0–1	4
17AL 605	Deep Learning	3–0–0	3

Subject Core

Course Code	Course	L–T–P	Cr
17AL 610	Principles of Automotive Systems	3–0–0	3
17AL 611	Automotive Grade Processors	3–0–1	4
17AL 612	Vehicle Dynamics and Control	3-0-1	4
17AL 613	Electric Vehicles and Architectures	3–0–0	3
17AL 614	Automotive Laboratory-I	0–0–1	1
17AL 615	Automotive Laboratory-II	0-0-1	1
17AL 616	Automotive Electronics Laboratory (OPEN LAB)	0–0–1	1

Electives

Course Code	Course	L–T–P	Cr
17AL 701	Vehicular Communication	3–0–0	3
17AL 702	Vehicular Networks	3–0–0	3
17AL 703	Power Converters for Automotive Applications	3–0–0	3
17AL 704	Electrical Machines for Automotive Applications	3–0–0	3
17AL 705	Control of Power Converters and Electrical Machines	3–0–0	3
17AL 706	Sensing for Autonomous Vehicles	3–0–0	3
17AL 707	Multi Sensor Data Fusion	3–0–0	3
17AL 708	Reinforcement Learning	3–0–0	3

Project

Course Code	Course	L–T–P	Cr
17AL797	Research Methodology	1-0-0	1
17AL798	Dissertation		8
17AL799	Dissertation		14

17AL601 LINEAR ALGEBRA AND OPTIMIZATION FOR SIGNAL PROCESSING 3-0-0-3

Vector and vector spaces , normed vector spaces, orthogonality and orthogonal bases , Orthogonal bases for signal processing (DCT, DFT ,WHT, Wavelet) , Vector spaces associated with a matrix , Projection matrices , Applications of projection matrices in regression and filter design. Eigenvalues and eigenvectors, Spectral decomposition, similar matrices, Singular value decomposition and applications, Dynamic mode decomposition for spatio-temporal data analysis.

Convex set and convex function, Mutivariate Taylor series expansion, optimality condition , Newton and quasi newton methods for unconstrained optimization, Constrained optimization, Lagrangian multiplier method, KKT conditions , Duality theorem, Alternating direction method of multipliers (ADMM) , LP and Convex QP with ADMM , Formulating signal processing and pattern classification problems as optimization problems.

Introduction to Variational calculus, Variational mode decomposition, Daubechies' synchrosqueezing transform.

TEXT BOOKS / REFERENCES:

1. Gilbert Strang, "Linear Algebra and Its Applications", Fourth Edition, Cengage, 2006.
2. Stephen P. Boyd and Lieven Vandenberghe D, "Convex Optimization", Cambridge University Press, 2004.
3. S. Boyd and L. Vandenberghe , "Vectors, Matrices, and Least Squares (DRAFT)"

17AL 602 AUTOMOTIVE EMBEDDED SYSTEMS 3–0–1–4

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, transmission systems: sensors, actuators & control, Chassis and Body Electronic Systems: Sensors and actuators for chassis and body systems, Comfort and control systems: HVAC, engine cooling, vehicle security, driver comfort and assistance, signalling and vision, safety system

Chassis control systems – ABS, ESP, TCS, ACC, Active Suspension System, Automatic transmission, 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, ADAS and Autonomous Vehicles

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, Overview of Other communication protocols: LIN, Flex ray.

TEXT BOOKS / REFERENCES:

1. William Ribbens, "Understanding Automotive Electronics – An Engineering Perspective", Eighth Edition, Butterworth Heinemann, 2017.
2. 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.
3. Tom Denton, "Automobile Electrical and Electronic Systems", Fourth Edition, Routledge, 2012.
4. Dominique Paret, "Multiplexed Networks for Embedded Systems: CAN, LIN, FlexRay, Safe–by–Wire", First Edition, Wiley, 2007.
5. Dominique Paret, "FlexRay and its Applications: Real Time Multiplexed Network", Second Edition, Wiley, 2012.

17AL 603 DIGITAL CONTROL SYSTEMS 3-0-0-3

Modelling of Sampled Data Systems: Sampled Data System, Models of Continuous Time Systems, Naturally Occurring Discrete Time Systems, Establishing Connections, Discretization of Continuous Time Systems.
Linear Systems: Basic Concepts, Basic Discrete Time Signals, Input–Output Convolution Models.
Z-Transform: Motivation and Definition of Z-Transform, Z-Transform Theorems and Examples, Transfer Function, Inverse of Z-Transform
Frequency Domain Analysis: Basics, Fourier Series and Fourier Transforms, Sampling and Reconstruction, Filtering, Discrete Fourier Transform
Transfer Function Approach to Controller Design: Control Structures, Lead-Lag controller, Proportional Controller, Proportional-Integral-Derivative Controller, stability and realizability.

TEXT BOOKS / REFERENCES:

1. Kannan Moudgalya, "Digital Control", John Wiley & Sons, 2007.
2. Norman S. Nise, "Control Systems Engineering", Sixth Edition, John Wiley & Sons, 2011.
3. Richard C. Dorf, Robert H. Bishop, "Modern Control Systems", Twelfth Edition , Pearson, 2010.

17AL604 REAL TIME OPERATING SYSTEMS FOR MULTI-CORE ENVIRONMENT 3-0-1-4

Real time operating systems (RTOS) basics: Introduction to real time systems – characteristics, features and types, operating system basics, services, kernel architecture, functions of RTOS kernel, existing RTOS category, Tasks, Process and Threads, task classification, task states, state transitions, task control block, task management, task scheduling– fixed priority and dynamic priority scheduling algorithms. Inter–task communication and synchronization, semaphores–inheritance, inversion, ceiling, deadlocks and starvation, priority inversion and mutexes, how to choose a RTOS for an application.
Multi tasking and Multi-core architectures: The challenges of multitasking and real-time, achieving multitasking with sequential programming, Instruction level parallelism (ILP), Static & Dynamic scheduling, Thread level parallelism, Multi–issue and Multi–core processors – Shared and Distributed memory Multiprocessor Architectures – mutex, semaphore and message queues, Multi–core architectures for embedded systems, Memory issues in multicore software, working with cache memory, memory contention, false sharing, memory consistency and inconsistency. Scheduler and multi-core scheduling, multiprocessing and multitasking.
Multi-core Systems-on-a-Chip: Amdahl's law, Fine-grained Vs Coarse-grained parallelism, Symmetric Vs Asymmetric Multiprocessing, operating systems for embedded multiprocessing, Symmetric Multiprocessing (SMP): operating systems support for SMP, Spinlocks, load balancing Vs Processor affinity, OpenMP. Asymmetric Multiprocessing (AMP): when to use AMP, operating systems for AMP, moving from uni-processing to AMP. RTOS for multi-core systems. Familiarization of AUTOSAR, OSEK/VDX.

TEXT BOOKS/REFERENCES:

1. Philip A. Laplante, "Real Time System Design and Analysis," Third Edition, PHI, 2004.
2. Jane W.S. Liu, "Real–Time Systems", First Edition, Pearson Education, 2000.

3. Kevin Roebuck, “AUTOSAR – Automotive Open System Architecture: High–Impact Strategies – What You Need to Know: Definitions, Adoptions, Impact, Benefits, Maturity, Vendors”, Emereo Pty Limited, 2011.
4. J.L. Hennessy and D.A. Patterson, “Computer Architecture: A Quantitative Approach”, Fifth Edition, Morgan Kaufmann, 2011.
5. Georgios Kornaros, “Multi–core Embedded Systems”, First Edition, CRC Press, 2010.

17AL605 DEEP LEARNING 3-0-0-3

Probability and Information Theory , Basics of classical Machine Learning techniques, algorithmic differentiation-forward and backward. Introduction to Neural Networks, Backpropagation, Multi-layer Perceptrons .
Overview of Computer vision Problems, Deep Learning for computer vision, Deep Feedforward Networks , Regularization for Deep Learning Optimization for Training Deep Models , Convolutional Networks , object detection and segmentation, Visualization and understanding, Generative models, Variational autoencoders, Sequence Modeling: Recurrent and Recursive Nets. Long short term memory networks (LSTM) .
Applications in security and Autonomous navigation.

TEXT BOOKS/REFERENCES:
Ian Goodfellow, Yoshua Bengio and Aaron Courville, “Deep Learning”, MIT Press, 2017

17AL 610 PRINCIPLES OF AUTOMOTIVE SYSTEMS 3–0–0–3

Internal combustion engines – Ideal cycles & actual cycles – Reciprocating piston engines – Operating principles – Mixture formation – Combustion – Modes of combustion – Emissions Charge cycle and supercharging/Turbocharging – Exhaust gas recirculation – Air filtration – Engine heat transfer

Test Procedures and Regulation for Engines, Emission Regulations/standards, Emission Measurement and Testing, Other Emission – Particulate – Crankcase – Evaporative - Refuelling.

Braking System – Principles, Components – Hydraulic Systems – Drum and Disc Brakes – Suspension System Components and Operation, Front and rear suspension – Steering systems – Columns and Gears – Steering Linkage – Power Assisted Steering Operation, Alignment Principles- Fundamentals of NHV

Basic Elements of Vehicle and Transmission Engineering – Selecting the Ratios -Overall Gear Ratio, Multi – plate clutches – Matching Engine and Transmission, Passenger Car Transmissions: Manual Passenger Car – Automated Manual Transmissions – Dual Clutch Transmissions – Automatic and Hybrid Drives –Continuously Variable Transmissions

TEXT BOOKS/REFERENCES:
1. Heywood J B, “Internal Combustion Engine Fundamentals”, McGraw-Hill, 1993.
2. Colin Ferguson R, “Internal Combustion Engines” John Wiley and Sons, 1989.
3. Rudolf Limpert, “Brake design and Safety”. SAE Publications, 2015,
4. Heinz Heisler, “Vehicle and Engine Technology”, Butterworth-Heinemann, 2010.

17AL611 AUTOMOTIVE GRADE PROCESSORS 3–0–1–4

Introduction to ARM Processor: ARM Processor–Processor Families – Pipelining in ARM – ARM Cortex M, A & R series – ARM7 Vs ARM Cortex M Series
ARM Cortex M3 Processor: Features of ARM Cortex M3 – ARM Cortex M3 Architecture – Programmer's Model – Interrupts and Exceptions – Operating Modes – Special Registers – Addressing Modes – ARM Instruction Set – THUMB Instruction Set – Basic ARM Assembly Language Programs.
ARM Peripherals & Embedded C Programming: Introduction to Embedded C – Introduction to Keil IDE – GPIO – Timers and Counters – Analog to Digital Converter – EEPROM Data Memory – UART – PWM Interfacing: LED, Temperature Sensor, DC Motor Driver, LCD and Keypad Interface.
Power Architecture from Freescale – Register Model- Instruction Model – Interrupts and Exceptions – Memory Management Unit – Instruction Pipeline and Execution Timing – External Core Complex Interfaces – Power Management.

TEXT BOOKS / REFERENCES:

1. Steve Furber, "ARM System On Chip Architecture", Addison Wesley, 2000.
2. Joseph Yiu, "The Definitive Guide to the ARM Cortex M3", Second Edition, Elsevier, 2010.
3. Arnold S. Berger, "Embedded System Design", CMP Books, 2002.
4. Michael Barr, "Programming Embedded Systems with C and GNU", O Reilly, 2003.
5. Freescale PowerPC Architecture Primer, Freescale Semiconductor, 2005.

17AL612 VEHICLE DYNAMICS AND CONTROL 3–0–1–4

Introduction to driver assistance systems, active stability control, ride quality, technologies for addressing traffic congestion, emissions and fuel economy; Lateral Vehicle Dynamics: Kinematic Models, Dynamic Bicycle Model, From Body Fixed to Global Coordinates; Lateral Vehicle Control: State Feedback, Steady State Analysis: Understanding Steady State Cornering, The Output Feedback Problem, Compensator Design with Look Ahead Measurement; Longitudinal Vehicle Dynamics: Longitudinal Vehicle Model, Driveline Dynamics, Mean Value Engine Models

Longitudinal Vehicle Control: Introduction: Cruise Control, Control System Architecture, Adaptive Cruise Control, Individual Vehicle Stability and String Stability, String Stability with Constant Spacing, String Stability with Constant Time Gap, Controller for Transitional Manoeuvres, Automated Highway Systems, Longitudinal Control for Vehicle Platoons, String Stability with Inter–Vehicle Communication, Adaptive Controller for Unknown Vehicle Parameters

Electronic Stability Control: Vehicle Model, Control Design for Differential Braking Based Systems, Control Design for Steer–by–Wire Systems, Independent All Wheel Drive Torque Control; Active Automotive Suspensions; Semi–Active Automotive Suspensions; Rollover Prevention Control: Rollover Dynamics, Rollover Index and Active Rollover Prevention, Comparison of Performance with Various Rollover Indices

Lab experiments based on simulation tools.

TEXT BOOKS/REFERENCES:

1. Thomas D. Gillespie, "Fundamentals of Vehicle Dynamics", SAE International, 1992.

2. R. Rajamani, “Vehicle Dynamics and Control”, Second Edition, Springer Verlag, 2012.
3. Uwe Kiencke and Lars Nielsen, “Automotive Control Systems: For Engine, Driveline, and Vehicle”, Second Edition, Springer, 2005.
4. John C. Dixon, “Tyres, Suspension, and Handling”, Second Revised Edition, SAE International, 1996.
5. Hans B. Pacejka, “Tyre and Vehicle Dynamics”, Second Edition, Butterworth–Heinemann, 2006.

17AL613 ELECTRIC VEHICLES AND ARCHITECTURES 3-0-0-3

Introduction to electric vehicles (EVs): Historical perspective. EV advantages and impacts. EV market and promotion: infrastructure needs, legislation and regulation, standardization, Functions electronically controlled in automotive.
Importance of energy efficiency / emission norms and fuel efficiency: Assessing economy of electric vehicles, Fuel economy vs fuel consumption Vs Green House Gas emissions.
Important electrical subsystem in vehicles: Basic components of a hybrid vehicle, Types of hybrids, Migration from 12V to 48V systems , Start/Stop Hybrid architecture types (Belt start Generator /Integrated Starter Generator), EV architectures.
Parallel Hybrid/ Series Hybrid (Range Extended Hybrid) Architectures: types, operating modes, torque coordination and control, generator/motor requirements. Introduction to power converter and motor control: case studies.
Batteries: Battery parameters. Types and characteristics of EV batteries. Battery testing and maintenance; charging schemes. Battery monitoring techniques. Open-circuit voltage and ampere-hour estimation. Battery load levelling, Chargers on-board/off-board chargers.

TEXT BOOKS / REFERENCES:

1. Iqbal Husain, “Electric and Hybrid Vehicles: Design Fundamentals”, CRC Press, 2005.
2. K. T. Chau, “Electric Vehicle Machines and Drives Design, Analysis and Application”, John Wiley and Sons, 2015.
3. Austin Hughes and Bill Drury, “Electric Motors and Drives, Fundamentals, Types and Applications”, Fourth Edition, Elsevier, 2013.
4. James Larminie, John Lowry, “Electric Vehicle Technology Explained”, John Wiley and Sons, 2003.
5. C.C. Chan and K.T. Chau, “Modern Electric Vehicle Technology”, Oxford University Press, 2001.

17AL 614 AUTOMOTIVE LABORATORY-I 0–0–1–1

This laboratory session shall provide an idea about various subsystems used in the Automotive Industry. Students will be performing experiments to study different aspects of the following automotive subsystems:
1. Working of Engine and valve timing
2. Steering system, Brake and Transmission systems
3. Performance test on a SI Engine – Fuelled with Gasoline / LPG
4. Heat balance test on Diesel Engine
5. Retardation test on Diesel Engine
6. Environmental Noise measurement
7. Pass-by-Noise measurement and analysis
8. In-Cabin Noise measurement and analysis

17AL 615 AUTOMOTIVE LABORATORY- II 0–0–1–1

This laboratory session shall provide an idea about various systems used in the Automotive Industry. Students will perform experiments on the following aspects of automotive systems:

1. Indian Driving cycle – Chassis dyno
2. Performance and emission test – 8 mode
3. Performance and emission test – 13 mode
4. Assess the Performance of Biofuel on engines
5. Assess the performance of Multiple coolant types on engines
6. Vibration measurement in Engines
7. Vibration measurement in Vehicles
8. Transfer path analysis
9. Psycho Acoustic Analysis

17AL 616 AUTOMOTIVE ELECTRONICS LABORATORY (OPEN LAB) 0–0–1–1

During the third semester, the students shall design and prototype a system, which is exclusively, used in the Body Electronics/ Chassis Control/ Power train/ Navigation domains of Automotive Electronics. The work will be evaluated periodically throughout the semester.

17AL 701 VEHICULAR COMMUNICATION 3-0-0-3

Vehicle-to-X (V2X) Communication for Intelligent Transportation Systems (ITS) - safety and non-safety applications, use cases, network service requirements of different applications, V2X communication regimes; Standards and Technologies - layered architecture, infrastructure-based vs. infrastructure-less technologies, Long-Term Evolution (LTE), Dedicated Short Range Communication (DSRC), Wireless Access in Vehicular Environments (WAVE); Wireless Propagation and Channel Characteristics - path loss, shadowing, small-scale fading, delay spread and Doppler spread, coherence bandwidth and coherence time, techniques for combating wireless channel impairments; Physical Layer - digital modulation schemes in DSRC, design of OFDM in DSRC (symbol time, sub-carrier spacing, pilot spacing); Medium Access Control (MAC) - 802.11p EDCA, multi-channel operation in the WAVE MAC; Routing - flooding, broadcast storm problem, Geocast; Security and Privacy in Vehicular Networks; Vehicular Network Simulation - mobility models, bidirectionally coupled road traffic and communication network simulators for vehicular network simulation.

TEXT BOOKS / REFERENCES:

1. Christophe Sommer and Falko Dressler, “Vehicular Networking”, Cambridge University Press, 2014.
2. Hannes Hartenstein and Kenneth Laberteaux(eds.), “VANET Vehicular Applications and Inter-networking Technologies”, John Wiley & Sons, 2009.
3. Claudia Campolo, Antonella Molinaro and Riccardo Scopigno, “Vehicular ad hoc Networks: Standards, Solutions, and Research”, Springer, 2015.
4. Theodore S. Rappaport, “Wireless Communications: Principles and Practice”, Second Edition, Prentice Hall, 2001.
5. Andrea Goldsmith, “Wireless Communications”, Cambridge University Press, 2005.

17AL702 VEHICULAR NETWORKS 3-0-0-3

In-Vehicle Communication Networks: A Historical Perspective and Review, CANFD Protocol: Overview of CANFD bus architecture – Physical Layer – Topology – frame architecture – CAN vs CANFD - Bit stuffing and CRC – Delay compensation – Error Handling – LIN Protocol: Overview – Frame Format – Bus Timing – Topology – Error detection – Sleep/Wake-up modes – Advanced Frames – MOST Protocol: Overview - Physical Layer – Network and Fault Management – Diagnostics – Interface Controller – Applications – Overview of Automotive Ethernet protocols

TEXT BOOKS/REFERENCES:

1.Richard Zurawski, "Industrial Communication Technology Handbook", Second Edition, CRC Press, 2014.
2. Gilbert Held, "Inter- and Intra-Vehicle Communications", Auerbach Publications, 2007.
3. Dominique Paret and Roderick Riesco, "Multiplexed Networks for Embedded Systems: CAN, LIN, FlexRay, Safe-by-Wire", John Wiley and Sons, 2007.
4. Chung-Ming Huang and Yuh-Shyan Chen, "Telematics Communication Technologies and Vehicular Networks: Wireless Architectures and Applications", Information Science Publishing, 2009.
5. Andreas Grzemba, "MOST- The Automotive Multimedia Handbook", Franzis Verlag GmbH, 2011.

17AL703 POWER CONVERTERS FOR AUTOMOTIVE APPLICATIONS 3-0-0-3

(Pre-requisite: 17AL613-Electric Vehicles and Architectures)

Overview of elementary power converter switches and power converters (non-isolated): BJT, Thyristors, MOSFETS, IGBT, IPM, IGCT. AC/DC converters single phase and three phase: Line commutated, uncontrolled and phase controlled converters (half bridge and full bridge), Performance factors, Line notching and distortion.

DC/DC converters isolated and non-isolated for automotive applications: buck, boost, buck-boost, SEPIC, SMPS concept, fly-back, forward, push-pull, soft switched bidirectional DC-DC converters, Typical specifications of power converters, design of power circuit to meet the specifications.

DC/AC converters three phase (focus on motor control): Voltage source inverters three phase Sinusoidal PWM and Space vector PWM, Multilevel inverters, Introduction to Cyclo-converters, Matrix Converters.
Magnetic Design (Inductor, Transformer, Core material and properties, Planar technology)

Battery Management Systems, Simulation tools for power converters (PSIM/pSpice/Simulink); Relevant Automotive Standards, Automotive Design Considerations: Power conditioning in power converters, High temperature applications, properties of silicon carbide devices.

TEXT BOOKS/ REFERENCES:

1. Ali Emadi, "Handbook of Automotive Power Electronics and Motor Drives", CRC Press, 2005.
2. Ned Mohan, Tore M. Undeland and William P.Robbins, "Power Electronics, Converters, Applications and Design", Third Edition, John Wiley and Sons Inc., 2006.
3. Muhammad H. Rashid, "Power Electronics, Circuits, Devices and Applications", Third Edition, PHI Pvt. Ltd., 2004.
4. John G. Kassakian, Martin F.Schlecht and George C.Verghese, "Principles of Power Electronics", Addison Wesley, 1991.

5. Bimal K Bose, “Modern Power Electronics and AC Drives”, PHI Pvt. Ltd., 2002.
6. Barry W Williams, “Principles and Elements of Power Electronics Devices, Drivers, Applications, and Passive Components”, MacMillan, 1987.

17AL704 ELECTRICAL MACHINES FOR AUTOMOTIVE APPLICATIONS 3-0-0-3

(Pre-requisite: 17AL703-Power Converters for Automotive Applications)

Review of Electromagnetics: Review of field equations, Maxwell’s equations, Principles of electromagnetic energy conversion.
DC Brushed Motors Analysis: Generalized theory of rotating electrical machines, modeling, steady state and transient analysis of separately excited DC machines.
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.
Synchronous Motors Analysis: Steady state and transient behavior of synchronous machines.
Brush-less DC Motors Analysis: Principle of working, Steady state operation, Torque calculation
Switched Reluctance Motors Analysis: Principle, Analysis, Steady state operation.
Simulation Techniques and tools.

TEXTBOOK/REFERENCES:

1. P.C.Krause, “Analysis of Electric Machines and Drive Systems”, Wiley International, 2002.
2. R. Krishnan, “Switched Reluctance Motor Drives: Modeling, Simulation, Analysis, Design, and Applications” CRC Press, 2001.
3. B. Adkins, “Generalized Machine Theory”, McGraw-Hill, 1964.
4. Ramu Krishnan, “Permanent Magnet Synchronous and Brushless DC Motor Drives”, CRC Press, 2010.
5. Saurabh Kumar Mukerji, Ahmad Shahid Khan and Yatendra Pal Singh, “Electromagnetics for Electrical Machines”, CRC Press, 2015.
6. K.T. Chau and Wenlong Li, “ Overview of Electric Machines for Electric and Hybrid vehicles” Department of Electrical and Electronic Engineering, International Journal of Vehicle Design, Vol.64, No.1, pp.46-71.

17AL705 CONTROL OF POWER CONVERTERS AND ELECTRICAL MACHINES 3-0-0-3

(Pre-requisites: 17AL704-Electrical Machines for Automotive Applications, 17AL603-Digital Control Systems)

Concept of state space analysis, Power Converter Transfer Functions (closely related to Elective I): sate space representation and Transfer function model of a DC-DC converter, Type I, Type II, Type III compensators, Analog Implementation of compensators, Digital Microcontroller/DSP) based implementation of compensators.
Control of Brushed DC Motors: Open and closed loop control of DC motors, Transfer function model of a separately excited DC motor. P, PI, PID controllers in DC motor control.
Control of Induction Motors: Scalar and vector control Technique, Slip Power Recovery Drive (Vehicle power train control-Drive cycle performance and testing), Introduction to sensorless control.
Control of Synchronous Motors: v/f control, vector control.
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 - Drive cycles performance and testing).

TEXT BOOKS /REFERENCES:

1. Katsuhiko Ogata, "State Space Analysis of Control Systems", Prentice Hall, 1967.
2. R. Krishnan, "Switched Reluctance Motor Drives: Modeling, Simulation, Analysis, Design, and Applications", CRC Press, 2001.
3. A.S Sedra and K.C Smith, " Microelectronic Circuits: Theory and Applications", Seventh Edition, Oxford University Press, 2017
4. R Krishnan, "Permanent Magnet Synchronous and Brushless DC Motor Drives", CRC Press, 2010.
5. Bimal K. Bose, "Modern Power Electronics and AC Drives", John Wiley & Sons, 2002.

17AL706 SENSING FOR AUTONOMOUS VEHICLES 3-0-0-3

Review of Signal Processing Techniques – Two dimensional signals and systems–Sampling in two dimensions–Two dimensional discrete transforms— DCT –DWT– Application to images –2D Hadamard Transform, Walsh Transform, KLT, Application to images– Z Transform and its properties, Application to images–Image Acquisition–Filtering in Spatial and Frequency domain–Image Compression– 3D signals and Systems–3D sampling and reconstruction–Digital Video Processing–Digital Video Compression – Case Studies: Pedestrian Detection Systems and ADAS.

Automotive Radar: Frequency Band Allocation and Standards – Elements of Automotive Radar – Antenna Systems and Requirements – Antenna Mounting – Radio Frequency Front End – Radar Signal Processors Requirements – Waveform Generation – Range Estimation – Case Studies. LIDAR: LIDAR based sensing-LIDAR Applications in Automotive systems.

TEXT BOOKS / REFERENCES:

1. Gregory L.Charvat, "Small and Short Range Radar Systems", CRC Press, 2014.
2. Byron Edde, "Radar – Principles, Technology, Applications", Pearson Education, LPE, Third Indian Reprint, 2005.
3. Merrill I.Skolnik, "Introduction to Radar Systems", Tata McGraw Hill, Third Edition, Twenty First Reprint, 2008.
4. C.R.Paul, "Introduction to Electromagnetic Compatibility", Second Edition, Wiley India Pvt. Ltd., 2014.
5. Rafael C. Gonzalez, "Digital Image Processing", Third Edition, PHI Pvt. Ltd., 2008.
6. John W. Wood, "Multidimensional Signal, Image, Video Processing and Coding", Elsevier, 2006.

17AL707 MULTI-SENSOR DATA FUSION 3-0-0-3

Introduction to the importance of multi-sensor systems and data fusion -Data representations and uncertainty –Strategies and algorithms for data fusion -Review of probability for data fusion -Bayesian methods for estimation and data fusion: Examples for discrete cases - Bayesian methods for estimation and data fusion: Continuous Gaussian case -Recursive Bayesian methods for estimation and data fusion – Kalman filter theory -Data fusion using the Kalman filter – Performance Evaluation of Data Fusion system - Fuzzy logic and decision fusion - Monte Carlo methods -Data fusion process models and architectures -Data association

TEXT BOOKS/REFERENCES:

1. Jitendra R Raol, "Multi Sensor Data Fusion", CRC Press, 2014.

2. David L. Hall, “Mathematical Techniques in Multisensor Data Fusion”, Artech House,
Boston, 1992.
3. R. Brooks and S.S. Iyengar, “Multisensor Fusion: Fundamentals and Applications with Software”, Prentice Hall Inc., New Jersey, 1998.
4. Arthur Gelb, “Applied Optimal Estimation”, M.I.T. Press, 1982.
5. James V. Candy, “Signal Processing: The Model Based Approach”, McGraw –Hill Book Company, 1987.

17AL708 REINFORCEMENT LEARNING 3-0-0-3

(Pre-requisite: 17AL605-Deep Learning)

Reinforcement learning and Markov Decision Processes (MDPs), Definition of MDPs , Exact algorithms: policy and value iteration, Search algorithms, Supervised learning and decision making, Optimal control and planning, Learning policies by imitating optimal controllers. Reinforcement learning definitions, value iteration, policy iteration, Reinforcement learning with policy gradients, Learning Q-functions: Q-learning, SARSA (State-Action-Reward-State-Action) and others, Advanced Q-learning algorithms. Introduction to Deep Reinforcement Learning (RL), Value-Based Deep RL, Policy-Based Deep RL, Model-Based Deep RL.

TEXT BOOKS/REFERENCES:

Richard S. Sutton and Andrew G. Barto, “Introduction to Reinforcement Learning”, Second Edition, MIT Press, 2017

17AL797 RESEARCH METHODOLOGY 1-0-0-1

Research Methodology – Selection of project domain – Topic – Literature Survey – Research Process – Research paper – Publication types – Quality Metrics – Impact Factor – Indexing – Citations – Project Proposal – Presentation – Report preparation; Research Ethics – Conflict of interest, Mentoring, Plagiarism, Case Studies and Presentations.

TEXTBOOKS / REFERENCES:

1. Kothari C R and Garg G, *Research Methodology: Methods and Techniques*, Third Edition, New Age International, 2014.
2. Louis G E, *Ethics in Engineering Research and Practice*, University of Virginia, 2010.

17AL 798 / 799 DISSERTATION 0-0-0-22

In Dissertation, the student will, with the help of a faculty member along with an Industry (TCS) Expert, identify a particular problem of interest in Automotive Electronics in the beginning of Second semester and study the state-of-the-art in the area of interest and develop a new technique /algorithm / device to obtain demonstrably better results than those presently available. The student shall submit a report in the end of Second semester, which contains a brief description, timeline, resources identified related to the work planned.

The evaluation of the dissertation will be based on the periodic reviews conducted throughout the Second year. Phase 1 evaluation (Presentation and Viva) of the Dissertation will be conducted by the Programme Coordinator and SME (Subject Matter Expert) at the end of Third Semester. Phase 1 of the dissertation will be worth 08 credits.

During the second phase of the Dissertation in the fourth semester, the student shall continue with the work initiated in Phase 1 to achieve the stated objectives of the project. At the end of this phase, the student shall submit a dissertation in the prescribed format. The Phase 2 (final) evaluation will be at the end of the fourth semester, which shall be attended by at least one eminent academician / researcher / technologist in the areas of Automotive Electronics. Phase 2 of the Dissertation will be worth 14 credits. In context of IP Protection, Research paper publication on a Scopus indexed Journal/ Conference by the candidate shall be based on prior approval from TCS and AMRITA

17EN 600 TECHNICAL WRITING P/F

Technical terms- Definitions- extended definitions- grammar checks- error detection- punctuation spelling and number rules - tone and style- pre-writing techniques - Online and offline library resources- citing references – plagiarism - Graphical representation - documentation styles- instruction manuals- information brochures- research papers, proposals – reports (dissertation, project reports etc.) - Oral presentations.

TEXT BOOKS / REFERENCES:

1. Hirish and Herbert L. “Essential Communication Strategies for Scientists, Engineers and Technology Professionals”, Second Edition, New York: IEEE Press, 2002.
2. Anderson, Paul V., “Technical Communication: A Reader-Centered Approach”, Sixth Edition, Cengage Learning India Pvt. Ltd., New Delhi, Reprint 2010.
3. Strunk, William Jr. and White E.B., “The Elements of Style” Alliyan & Bacon, New York, 1999.