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.

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

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Type</th>
<th>Course</th>
<th>L–T–P</th>
<th>Cr</th>
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<tbody>
<tr>
<td>MA 613</td>
<td>FC</td>
<td>Linear Algebra and Theory of Optimization</td>
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<td>Automotive Embedded Systems</td>
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<tr>
<td>AL 610</td>
<td>SC</td>
<td>Fundamentals of Automotive Systems</td>
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<td>AL 611</td>
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<td>Introduction to Computer Architecture</td>
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<tr>
<td>HU 601</td>
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<td>Cultural Education*</td>
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* Non-credit course

### Second Semester

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<tr>
<td>AL 612</td>
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<td>Automotive Power Electronics and Drives</td>
<td>3–0–1</td>
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<td>AL 613</td>
<td>SC</td>
<td>Automotive Grade Processors</td>
<td>3–0–1</td>
<td>4</td>
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<td>AL 614</td>
<td>SC</td>
<td>Real Time Operating Systems</td>
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<td>Elective – I</td>
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<td>AL 616</td>
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<td>Automotive Testing Systems Laboratory</td>
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<td>EN 600</td>
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* Non-credit course

### Third Semester

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<td>Elective – III</td>
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<td>Dissertation</td>
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**TOTAL CREDITS: 66**
## LIST OF COURSES

### Foundation Core

<table>
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<tbody>
<tr>
<td>MA 613</td>
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<tr>
<td>AL 601</td>
<td>Automotive Embedded Systems</td>
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<tr>
<td>AL 602</td>
<td>Automotive Control Systems</td>
<td>3–1–0</td>
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### Subject Core

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<th>Course Code</th>
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<th>Cr</th>
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<tbody>
<tr>
<td>AL 610</td>
<td>Fundamentals of Automotive Systems</td>
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<tr>
<td>AL 611</td>
<td>Introduction to Computer Architecture</td>
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<td>AL 612</td>
<td>Automotive Power Electronics and Drives</td>
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<td>AL 613</td>
<td>Automotive Grade Processors</td>
<td>3–0–1</td>
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<td>AL 614</td>
<td>Real Time Operating Systems</td>
<td>3–0–1</td>
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<td>AL 615</td>
<td>Vehicular Networks and Communication</td>
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<td>AL 616</td>
<td>Automotive Testing Systems Laboratory</td>
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<td>AL 617</td>
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### Electives

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<tr>
<td>AL 701</td>
<td>Automotive Sensors</td>
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<td>AL 702</td>
<td>Multi Core Architectures for Automotive Applications</td>
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<td>AL 703</td>
<td>Vehicle Dynamics and Control</td>
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<td>AL 704</td>
<td>Introduction to Artificial Intelligence</td>
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<td>AL 705</td>
<td>Automotive RADAR Systems</td>
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<tr>
<td>AL 706</td>
<td>Hardware Software Co–design for Automotive Applications</td>
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<td>AL 707</td>
<td>Fuzzy Based System Design for Automotive Applications</td>
<td>3–0–0</td>
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<td>AL 708</td>
<td>Digital Signal Processing</td>
<td>3–0–0</td>
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<tr>
<td>AL 709</td>
<td>Batteries and Fuel Cells</td>
<td>3–0–0</td>
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<tr>
<td>AL 710</td>
<td>Micro Electro–Mechanical Systems (MEMS)</td>
<td>3–0–0</td>
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<tr>
<td>AL 711</td>
<td>Introduction to Data Mining</td>
<td>3–0–0</td>
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<tr>
<td>AL 712</td>
<td>Digital Image and Video Processing</td>
<td>3–0–0</td>
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TEXT BOOKS / REFERENCES:

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, Control systems, Power storage and generation, Starting motor systems, comfort and control systems: HVAC, engine cooling, vehicle security, driver comfort and assistance, signaling and vision, safety system, instrumentation systems and diagnostics

Cruise control and adaptive cruise control systems – ABS, ESP, TCS, 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 Systems, Application IoT in automotives, Future of Automotive Embedded systems

TEXT BOOKS / REFERENCES:

AL 602 AUTOMOTIVE CONTROL SYSTEMS 3–1–0–4


Road and driver Models: Road Model–Requirements of the road model, definition of the course path, Road surfaces and wind strength; PID Driver model; Hybrid Driver Model–Vehicle control tasks, characteristics of human as a controller, Information handling, completer driver model.
Lab based simulations of Control systems

TEXT BOOKS / REFERENCES:

AL 610 FUNDAMENTALS OF AUTOMOTIVE SYSTEMS 3–0–0–3

Internal combustion engines – Ideal cycles & actual cycles – Reciprocating piston engines – Operating principles – Mixture formation – Combustion – Emissions – Charge cycle and


TEXT BOOKS / REFERENCES:

AL 611 INTRODUCTION TO COMPUTER ARCHITECTURE 3–0–0–3


TEXT BOOKS / REFERENCES:
2. J. Šilc, B. Robic and T. Ungerer, “Processor Architecture: From Dataflow to Superscalar

AL 612 AUTOMOTIVE POWER ELECTRONICS AND DRIVES 3–0–1–4

Evolution of the distribution electrical system: Electrical and electronic systems in the vehicle, Conventional system of electrical distribution in automobiles, Peaking power sources and energy storages: fuel cells, Batteries (lead, nickel, lithium), super capacitors, flywheel and hybridization of energy storage Role of power electronics in vehicles, Characteristics of power semiconductor switches– power diodes, power transistors and thyristors, Selection of devices

Power Electronic Converters: AC– DC Converters, DC–DC Converters, AC–AC Converters, DC–AC Converters Electric propulsion system: DC motor drives: Basic characteristics, Combined armature voltage and field control, Operating modes, Chopper drives, Regenerative braking, Effects of changes in supply voltage and load torque, closed loop control systems


TEXT BOOKS / REFERENCES:

AL 613 AUTOMOTIVE GRADE PROCESSORS 3–0–1–4


ARM Peripherals & Embedded C Programming: Introduction to Embedded C – Introduction to Keil IDE – GPIO – Timers and Counters – Analog to Digital Converter – EEPROM Data Memory –

TEXT BOOKS / REFERENCES:

AL 614 REAL TIME OPERATING SYSTEMS 3–0–1–4

Introduction to Real–time Systems and Real Time Operating System Basics: Real–time systems–definitions and examples, real–time systems characteristics, timeliness, responsiveness, concurrency, determinism, correctness and robustness, requirements on RTOS, RTOS Vs General–purpose OS, RTOS characteristic, existing RTOS category, kernel architecture, functions of RTOS kernel.

Introducing tasks for concurrency: Task management, process, thread and task, task– basic notation in RTOS, task classification, task states, state transitions, task control block, context switching and latency, creating, controlling, deleting tasks, setting priorities, writing re–entrant codes, scheduling policies– fixed priority and dynamic priority scheduling algorithms. Inter–Task Communication and Synchronization: Inter task communication: with and without resource sharing, shared memory, message and message queues, inter–task communication via message queues, inter–task communication models, need for synchronization, semaphores–binary and counting semaphores, inheritance, inversion, ceiling, deadlocks and starvation, priority inversion and mutexes.

Time, Memory and Interrupt handling: Clocks in distributed RTS, timers and timer ticks, clock synchronization, watch dog timer, relative and absolute timer, interrupts– ISR under RTOS, ISR to task communication, memory/ device I/O management. Introduction to Multi threading and Multi processor scheduling

Case study: AUTOSAR, OSEK/VDX, Picking an RTOS for your project, RTOS trends today and for next five years.

Lab experiments based on standard RTOS

TEXT BOOKS / REFERENCES:
5. AUTOSAR Specification Available at: http://www.autosar.org/specifications/

AL 615 VEHICULAR NETWORKS AND COMMUNICATION 3–0–1–4


Lab experiments based on various vehicular communication/ network protocols/standards

TEXT BOOKS / REFERENCES:

AL 616 AUTOMOTIVE TESTING SYSTEMS LABORATORY 0–0–1–1

This laboratory session shall provide an idea about various testing systems used in the Automotive Industry. The list of experiments will be based on the facility available with the Testing Systems Lab.

AL 617 AUTOMOTIVE ELECTRONICS OPEN LABORATORY 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.
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:

AL 701 AUTOMOTIVE SENSORS 3–0–0–3

GPS: Basic navigation; GNSS segments; Satellite systems; Stand–alone and referenced positioning; Receiver systems; Topographic maps; Route planning; Waypoints; Trail mapping; Turn–by–turn guidance LIDAR: EM theory of EO systems; Radiation metrics; Optical modulation; Error correction codes; Channel models
AMOLED: Basic Principles; Controllers; Controllers; Noise management; ITO; OGS; Stylus Technologies; Touch less authentication; Biometric access control, MEMS: Introduction; Noise factor; Piezoelectric systems; Capacitive sensing; Signal amplification; Sensor specifications and Damping; Actuation; RF MEMS; Micro fabrication techniques
Virtual sensors: Models and algorithms for Efficient performance of sensor networks; Information pattern analysis; Real–world applications

TEXT BOOKS / REFERENCES:
AL 702  MULTI CORE ARCHITECTURES FOR AUTOMOTIVE APPLICATIONS  3–0–0–3


TEXT BOOKS / REFERENCES:
3. Freescale e200z3 Power Architecture Core Reference Manual.

AL 703  VEHICLE DYNAMICS AND CONTROL  3–0–0–3

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


Control with Hydraulic Actuators; Semi–Active Automotive Suspensions: Theoretical Results: Optimal Semi–Active Suspensions, Interpretation of the Optimal Semi–Active Control Law, Calculation of Transfer Function Plots with Semi–Active Control Law; 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:

AL 704 INTRODUCTION TO ARTIFICIAL INTELLIGENCE 3–0–0–3

Introduction to basic principles of Artificial Intelligence, Knowledge representation: Formalized symbolic logics – Dealing with uncertainties – Statistical reasoning – Structured Knowledge – Object oriented representations


Knowledge acquisition: General learning model – Neural networks – Fuzzy logic systems – Genetic algorithms – Learning by induction – Artificial Intelligence for sensing, control and diagnostics in automotive systems – Programming techniques for Artificial Intelligence using PROLOG. – Application of Multi Sensor Data Fusion Techniques

TEXT BOOKS / REFERENCES:

AL 705 AUTOMOTIVE RADAR SYSTEMS 3–0–0–3


TEXT BOOKS / REFERENCES:

AL 706 HARDWARE SOFTWARE CO–DESIGN FOR AUTOMOTIVE APPLICATIONS 3-0-0-3


TEXT BOOKS / REFERENCES:

AL 707 FUZZY BASED SYSTEM DESIGN FOR AUTOMOTIVE APPLICATIONS 3–0–0–3

Logic and Fuzzy systems – Automated methods – Decision Making – Fuzzy Classification – Fuzzy control systems design.


TEXT BOOKS / REFERENCES:

AL 708 DIGITAL SIGNAL PROCESSING 3–0–0–3


Digital Filter Design and Filter Realization: FIR and IIR filters Applications : Multirate digital signal processing – Evaluation of time domain and frequency domain features for machine vibration analysis

TEXT BOOKS / REFERENCES:
   India Private Limited, 1997.

AL 709   BATTERIES AND FUEL CELLS               3–0–0–3

Origin of potential – electrical double layer – reversible electrode potential–emf series–reference and
indicator electrodes – Nernst equation – Butler–Volmer equation – Activation, concentration and IR
over potentials – Tafel plots – Primary and secondary batteries: The chemistry, fabrication and
performance aspects, packing classification and rating of zinc and lithium primary batteries–Lead
acid, nickel, silver and lithium ion secondary batteries–VRLA batteries–Sodium–beta and Redox
batteries for vehicles – Thermally activated reserve batteries

Fuel Cells: Working principle, fabrication of electrodes and other components, and environmental
aspects of Proton Exchange Membrane Fuel Cells, Alkaline fuel cells, Phosphoric acid, Solid oxide,
Molten carbonate, Direct methanol fuel cells – Reformation clean up and storage for hydrogen –
Testing and Assessment of Batteries – Shelf life and service life – effect of temperature and pressure
– effect of aging – memory effect – test conditions, mechanical and environmental, load and
electromagnetic compatibility testing. Selected international standards – performance characteristics
– Peuckert discharge curves, Ragone plots,

Introduction to Fuel cell control systems, Battery management systems.

TEXT BOOKS / REFERENCES:
1. Dell, Ronald M Rand and David AJ, “Understanding Batteries”, Royal Society of Chemistry,
5. Derek Pletcher and Frank C. Walsh, “Industrial Electrochemistry”, Blackie Academic and
   Professional, 1993.

AL 710   MICRO ELECTRO–MECHANICAL SYSTEMS (MEMS)    3–0–0–3

Introduction to MEMS Technology & Applications – Evolution of Micro-fabrication, Microsystems
and Microelectronics, Microsystems Design and Manufacture: Inter– and Multi–disciplinary Nature,
Microsystems and Miniaturization, Application of Microsystems in Automotive Industry – Sensors
and Actuators; Fundamentals of Thin Film and Microsystems Fabrication Processes –
Photolithography, Ion Implantation, Diffusion, Oxidation, Chemical Vapor Deposition, Physical Vapor Deposition, Sputtering, Deposition by Epitaxy, Etching


TEXT BOOKS / REFERENCES:

AL 711 INTRODUCTION TO DATA MINING 3–0–0–3

Measuring the central tendency, measuring the dispersion of data, graphic displays of basic descriptive data summaries. Missing values, noisy data, data cleaning as a process. Data integration, data transformation. Data cube aggregation, attribute subset selection, dimensionality reduction using PCA. Fundamentals of streaming data mining


Cluster Analysis using k–Means, k–Medoids, single linkage, complete linkage, UPGMA, BIRCH, ROCK. Assessing clustering tendency, determining the number of clusters, measuring clustering quality. Concepts of data stream mining, Big data analytics, Case studies on application of data mining techniques in automotive industry.

TEXT BOOKS / REFERENCES:

AL 712 DIGITAL IMAGE AND VIDEO PROCESSING 3–0–0–3 (Prerequisite: Signal Processing for Automotive applications)


TEXT BOOKS/REFERENCES:

AL 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.