



# M.Tech in Automotive Electronics



## **National Institute of Electronics and Information Technology**

(An Autonomous Scientific Society of Ministry of Electronics and Information  
Technology, Government of India)

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### **M. TECH – AUTOMOTIVE ELECTRONICS**

#### **National Institute of Electronics and Information Technology**

Technology development has seen growth in leaps and bounds primarily in the Passenger Car Segment (PCS). The electronic content in cars started with the introduction of the in-car entertainment system, alternators, regulators and other electronics components. Other technological developments in the field of auto electronics were the result of Customer demand and Legislative Pull. Growing electronics content in PCS has led to the growth of the Global Auto Electronics market to \$230 billion in 2020; up from \$140 billion in 2010. With a growing number of sensors and ECUs installed, the overall cost of electronics in a car is expected to reach 45% by 2030 (ACM Report). With highly dynamic market scenarios, the Asia Pacific market is expected to drive the growth of Auto Electronics worldwide. Government mandate on emission norms and safety norms are the major thrust for the growth of electronics content in Powertrain and Safety programs worldwide.

The introduction of electronic substitutes in vehicles with a gradual phase-out of mechanical components also has fueled the growth of the auto electronics market. Legislative and Customer Pull are leading to the advent of new technologies across vehicle segments (PV, CV, and 2W) such as ABS, Rear lighting control, Active Suspension and others. Ninety per cent of innovations in the modern car are based on new developments in electronics.

Increase in the complexity of modern cars also increases the demands placed on design, development, diagnostics, maintenance and repair. Currently there is a great shortage of qualified automotive engineers with good design and development skills. Vehicles will continue to become more complex; therefore, the need for skilled human resources will continue to grow. Hence there need a unique training program in automotive electronics with an emphasis on electronics system of Vehicles. M.Tech in Automotive Electronics is designed to cater to the needs of skill requirements in Industries.

#### **Program Education Objectives (PEO)**

**PEO1:** To gain expertise and proficiency in the broader domains of automotive electronics and computation, enabling success in contemporary industry, academia, or research.

**PEO2:** To understand, assess, formulate, and develop innovative problem-solving approaches within the realm of Automotive Electronics that are technically, economically, and socially feasible and acceptable.

**PEO3:** To demonstrate professional proficiency and leadership attributes, harmoniously integrating ethical principles for comprehensive personality development.

#### **Program Outcomes (PO)**

- PO1 The capability to autonomously conduct research, investigation, and developmental tasks to address real-world challenges.
- PO2 Proficiency in composing and delivering a comprehensive technical report or document.

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- PO3 An ability to demonstrate a degree of mastery over the area as per the specialization of the program
- PO4 The capability to showcase a level of mastery corresponding to the program's specialization area.
- PO5 The skill to participate in self-directed and lifelong learning within the context of evolving technology and industrial requirements.

Semester-I		
S. No	Course Code	Course Name
1.	AEL601	Program Core-I Automotive Embedded System
2.	AEL602	Program Core-II Automotive Engine Management and Sensors Systems
3.	AEL***	Program Elective-I
4.	AEL***	Program Elective-II
5.	ACL601	Research Methodology and IPR
6.	ACL602	Audit course
7.	AEP601	Laboratory-I (Embedded Computing and Programming)
8.	AEP***	Laboratory-II (Based on Electives)

Semester-II		
S. No	Course Code	Course Name
1.	AEL603	Program Core-III Vehicle Dynamics & Control
2.	AEL604	Program Core-IV Automotive networking and protocols
3.	AEL***	Program Elective-III
4.	AEL***	Program Elective-IV
5.	ACL***	Audit Course
6.	AEP604	Laboratory-III Automotive Control and Vehicle Simulation Lab

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7.	AEP***	Laboratory-IV (Based on Electives)
8.	AED601	Mini project with Seminar

Semester-III		
S. No	Course Code	Course Name
1.	AEL***	Program Elective-V
2.	OEL***	Open Electives
3.	AED701	Dissertation-I/ Industrial project

Semester-IV		
S. No	Course Code	Course Name
1.	AED702	Dissertation-II

# Core Subject Syllabus

Course Code	Course Title				
<b>AEL601</b>	<b>Automotive Embedded System</b>				
<b>Pre-requisite</b>	<b>Nil</b>				
<b>Course Objectives</b>					
The course is aimed at					
<ol style="list-style-type: none"> <li>1. To introduce design concepts of embedded systems.</li> <li>2. To provide insights on embedded C programming for configuring microcontrollers and peripherals</li> <li>3. To enable the development of embedded system models.</li> </ol>					
<b>Course Outcome</b>					
At the end of the course, the student will be able to					
<ol style="list-style-type: none"> <li>1. Able to identify the features of the STM32F microcontroller.</li> <li>2. Able to apply embedded C programming skills for configuring STM32F peripherals.</li> <li>3. Able to analyze external peripheral interfacing with a microcontroller.</li> <li>4. Able to design and develop embedded systems using STM32F microcontroller.</li> </ol>					
<b>Module:1 ARM Architecture</b>					
STM32F Processor: Introduction to Embedded Systems - Introduction to ARM - Advanced RISC Features - Core Data path - Register Organization - System Architecture - Memory Organization - Low Power Modes - Power Control Registers - Backup Registers - Programming STM32F					
<b>Module:2 Embedded Peripheral Interfacing and Programming</b>					
STM32F Peripherals: Introduction to Embedded C Programming - General Purpose Input Output - UART - ADC - DAC - Timers - Interrupts and Exceptions - PWM - SPI.					
<b>Module:3 Embedded Applications</b>					
External Peripheral Interfacing: LCD - Keypad - Motor - Servo Motor - EEPROM - Seven Segment Interfacing - Sensor Interfacing.					
<b>Text Book(s)</b>					
<ol style="list-style-type: none"> <li>1. Muhammad Ali Mazidi, <i>STM32 Arm Programming for Embedded Systems</i>, 2019.</li> <li>2. Donald Norris, <i>Programming with STM32: Getting Started with the Nucleo Board and C/C++</i>, McGraw-Hill Education, 2018</li> </ol>					
<b>Reference Books</b>					
<i>STM32F446xx advanced Arm®-based 32-bit MCUs, Reference Manual</i> , 2020					

Course Code	Course Title				
<b>AEL602</b>	<b>Automotive Engine Management and Sensors Systems</b>				
<b>Pre-requisite</b>	<b>Nil</b>				
<b>Course Objectives</b>					

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The course is aimed at

1. Giving details of the Engine sensor waveforms and methods to analyze the same.
2. Providing an overview of petrol and diesel engines using Engine Control Unit (ECU).
3. Giving insights into the operation of ECU with the suitable mapping of sensors.

### Course Outcome

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

1. Comprehend the concepts of ECU design for automotive applications.
2. Analyze response of Transducers and sensors for automotive applications
3. Understand the various after treatment and alternative fuel-based systems.
4. Comprehend the operation of petrol engine management systems.
5. Understand the operation of automotive sensors and fuel injection systems.
6. Comprehend the Electronic control unit pertaining to chassis and body.
7. Illustrate the various Automotive subsystems.

### Module:1 Electronic Control Unit(ECU) Design

The concepts of ECU design for automotive applications, Need for ECUs, advances in ECUs for automotive, design complexities of ECUs, V-Model for Automotive ECU's Architecture, analog and digital interfaces.

### Module:2 Basics of Engine Control systems

IC engines operation – Petrol and Diesel; IC engine as a propulsion source for Automobiles; the need for engine controls and management; Control objectives linked to fuel efficiency, emission limits and vehicle performance; advantages of using Electronic engine controls.

### Module:3 Petrol Engine Management Systems

Evolution of Petrol engine controls, Electronic ignition, multi-point fuel injection, direct injection; Basics of ignition system and fuel injection system; Architecture of a EMS with multi point fuel injection.

### Module:4 Diesel Engine Management Systems

Basics of Diesel engine Controls ; Evolution of diesel engine controls; in-line fuel pump; rotary fuel pump; EGR control; Electric motor driven fuel pump; electronic fuel injection control and timing.

### Module:5 After Treatment and Alternate Fuel

Automobile emission – source, control, tests, standards (Indian), Exhaust Gas Recirculation(EGR), Catalytic converter, Alternative fuels – hydrogen – CNG, LPG, Biodiesel.

### Module:6 Transducer Principles

Transducers classification and basic principles, General Input-output configuration, static characteristics and dynamic characteristics of instruments, Variable resistance transducers, Metal and semiconductor strain gages and their signal conditioning ,Inductive transducers, Electromagnetic sensors, Hall effect sensors, Capacitive transducers, Piezo electric transducers and their signal conditioning, Ultrasonic sensors.

### Module:7 Sensors for Transportation

Vehicle Body:- Torque sensors/ Force sensors, Sensors Flap air flow sensors, Temperature sensor, Ultrasonic sensors, Ranging radar (ACC) Power Train:- Fuel level sensors, Speed and RPM sensors, Lambda Oxygen sensor, Hotwire air mass meter Chassis:- Steering wheel angle sensor, Vibration and acceleration sensors, Pressure sensors, Speed and RPM sensors.

### Text Book(s)

1. Fundamentals of Internal Combustion Engines - H.N. Gupta - Second edition (2015) – PHI publisher
2. Internal Combustion Engines - 2012 -V Ganesan –Tata McGraw Hill
3. Automotive Sensors (Sensors Technology) –2009 by John Turner & Joe Watson(Author)

### Reference Books

1. Automotive Sensors, BOSCH. 2002
2. Fundamentals of Automotive Electronics Book - Sixth Edition-2015 - Alma Hillier

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Course Code	Course Title				
<b>AEL603</b>	<b>VEHICLE DYNAMICS AND CONTROL</b>				
<b>Pre-requisite</b>	<b>Nil</b>				
<b>Course Objectives</b>					
The course is aimed at <ol style="list-style-type: none"> <li>1. To introduce the fundamentals of automated highway systems and driver assistance systems.</li> <li>2. To create a complete understanding of various forces acting on the vehicle during acceleration and cornering and design various systems to control them.</li> <li>3. To understand the generation of lateral force during cornering and design and develop a control system</li> </ol>					
<b>Course Outcome</b>					
At the end of the course, the student will be able to <ol style="list-style-type: none"> <li>1. Ability to understand the fundamentals vehicle dynamics</li> <li>2. Ability to identify various forces and control them during acceleration and braking</li> <li>3. Ability to gain fundamental knowledge of force generation during cornering</li> <li>4. Ability to develop a control system for reducing the effect of lateral forces</li> </ol>					
<b>Module:1</b>					
Introduction - Automated highway system and driver assistance systems- Longitudinal vehicle control – Introduction - Longitudinal vehicle model - From body fixed to global coordinates - Driveline dynamics - Mean value engine models - Anti-lock braking system and control system design - Cruise control - Adaptive Cruise Control (ACC) - Control system architecture for ACC - Controller for transitional maneuvers - Overview.					
<b>Module:2</b>					
Lateral vehicle dynamics - Kinematic models - Dynamic bicycle model - Lateral vehicle control- State feedback - Steady state analysis - Understanding steady state cornering - The output feedback problem - Compensator design with look ahead measurement - Active stability control - Ride quality.					
<b>Module:3</b>					
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 - Rollover in passenger cars and heavy commercial vehicles with trailers.					
<b>Text Book(s)</b>					
<ol style="list-style-type: none"> <li>1. R. Rajamani, <i>Vehicle Dynamics and Control</i>, Second Edition, Springer Verlag, 2012.</li> <li>2. Hans B. Pacejka, <i>Tyre and Vehicle Dynamics</i>, Third Edition, Butterworth–Heinemann, 2012.</li> <li>3. Thomas D. Gillespie, <i>Fundamentals of Vehicle Dynamics</i>, SAE International, 1992.</li> </ol>					
<b>Reference Books</b>					
<ol style="list-style-type: none"> <li>1. Uwe Kiencke and Lars Nielsen, <i>Automotive Control Systems: For Engine, Driveline, and Vehicle</i>, Second Edition, Springer, 2005.</li> <li>2. John C. Dixon, <i>Tyres, Suspension and Handling</i>, Second Revised Edition, SAE International, 1996.</li> </ol>					
Course Code	Course Title				

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<b>AEL604</b>	<b>Automotive Networking and Protocols</b>				
<b>Pre-requisite</b>	<b>Nil</b>				
<b>Course Objectives</b>					
The course is aimed at:					
<ol style="list-style-type: none"> <li>1. Providing an overview of automotive network systems.</li> <li>2. Exposing students to the aspects of design, development, application and performance issues associated with automotive network systems.</li> </ol>					
<b>Course Outcome</b>					
At the end of the course, the student will be able to					
<ol style="list-style-type: none"> <li>1. Illustrate the basics of automotive networking and protocols</li> <li>2. Comprehend the general protocols and their usage in automotive sector</li> <li>3. Understand the LIN protocol and implement inconvenience feature applications</li> <li>4. Design and implement CAN protocol for chassis and power train applications</li> <li>5. Understand the concepts of time triggered protocols and it's usage in automotive field</li> <li>6. Design and implement in media-oriented system transport protocol applications</li> <li>7. Understand FlexRay protocol and their usage in safety critical applications</li> </ol>					
<b>Module:1</b>	<b>Introduction to Automotive Networking</b>				
Overview of Data communication and networking –need for In-Vehicle networking –layers of OSI reference model –multiplexing and de-multiplexing concepts –vehicle buses.					
<b>Module:2</b>	<b>General purpose protocols</b>				
Overview of general purpose networks and protocols –Ethernet, TCP, UDP, IP					
<b>Module:3</b>	<b>Protocol for low data rate applications</b>				
LIN standard overview –workflow concept-applications –LIN protocol specification –signals – Frame transfer –Frame types –Schedule tables –Task behaviour model –Network management – status management.					
<b>Module:4</b>	<b>Protocol for medium data rate applications</b>				
Overview of CAN –fundamentals –Message transfer –frame types–Error handling –fault confinement–Bit time requirements					
<b>Module:5</b>	<b>Time triggered protocol</b>				
Introduction to CAN open –TTCAN –Device net –SAE J1939					
<b>Module:6</b>	<b>Protocol for infotainment</b>				
MOST –Overview of data channels –control channel-synchronous channel –asynchronous channel –Logical device model –functions-methods-properties-protocol basics- Network section-data transport –Blocks –frames –Preamble-boundary descriptor					
<b>Module:7</b>	<b>Protocols for safety critical applications</b>				
FlexRay-Introduction –network topology –ECUs and bus interfaces –controller host interface and protocol operation controls –media access control and frame and symbol processing – coding/decoding unit					
<b>Text Book(s)</b>					
1. J.Gabrielleen, Automotive in-vehicle networks, John Wiley & Sons, Limited, 2016					
<b>Reference Books</b>					
1. Robert Bosch, Bosch automotive networking, Bentley publishers, 2007					
2. Society of automotive engineers, In-vehicle networks, 2015					
3. Ronald K Jurgen, —Automotive Electronics Handbook, McGraw-Hill Inc. 1999.					
4. Indra Widjaja, Alberto Leon-Garcia, —Communication Networks: Fundamental Concepts and Key Architectures, McGraw-Hill College; 1st edition, 2000.					
5. Konrad Etschberger, Controller Area Network, IXXAT Automation, August 22, 2001.					
6. Olaf Pfeiffer, Andrew Ayre, Christian Keydel, —Embedded Networking with CAN and CANopen, Anna books/Rtc Books, 2003					

# **Elective Courses Syllabus**

<b>Course Code</b>	<b>Course Title</b>				
<b>AEL701</b>	<b>Data Acquisition and Signal Conditioning</b>				
<b>Pre-requisite</b>	<b>Nil</b>				
<b>Course Objectives</b>					
The course is aimed at:					
<ol style="list-style-type: none"> <li>1. Imparting an in-depth knowledge in sensor signal conditioning, signal conversion, data acquisition, signal processing, transmission and analysis.</li> <li>2. Providing a comprehensive coverage of data acquisition methods for sensor systems and hardware interface cards available commercially.</li> <li>3. Enabling the students to do acquire the necessary skills to undertake project work using Multisim and LabView</li> </ol>					
<b>Course Outcome</b>					
At the end of the course, the student will be able to					
<ol style="list-style-type: none"> <li>1. Understand the basics of amplifier for designing circuits</li> <li>2. Design the circuits using amplifiers for automotive applications</li> <li>3. Estimate drift in resistors over a period of time and also to learn non-linear signal processing techniques</li> <li>4. Design different converter like ADC, DAC and voltage to frequency converter</li> <li>5. Gain knowledge about interference, grounding and its effects the circuitry</li> <li>6. Understand the data operation of loggers, data acquisition boards and software for acquiring the samples</li> <li>7. Describe different standards like RS232, GPIB which will be used for interfacing with the DAQ boards</li> </ol>					
<b>Module:1 Linear Integrated Circuits</b>					
Introduction to amplifier–amplifier parameters –operational amplifiers - Differential amplifiers instrumentation amplifier					
<b>Module:2 Amplifiers</b>					
carrier amplifiers –Lock-in-Amplifiers –chopper and low drift amplifiers –electrometer and transimpedance amplifiers –charge amplifier –isolation amplifier					
<b>Module:3 Non-linear signal processing techniques</b>					
Limiting, clipping, logarithmic amplification, multiplication and division –analog linearization –special purpose signal conditioners –Noise in amplifiers –noise and drift in resistors					
<b>Module:4 Signal Conversion</b>					
Voltage to frequency converter –capacitance to period converter –frequency to code conversion - sampling concepts –pre filtering –Sample and Hold amplifier –Analog-to-Digital converters - multiplexers and De-multiplexers –Digital-to Analog converters					
<b>Module:5 Data transmission</b>					
Data transmission systems –pulse code format –modulation techniques –telemetry –noise and interference –types and reduction –signal circuit grounding –shield grounding –capacitive, magnetic and optical isolation.					
<b>Module:6 Data Acquisition System</b>					
DAS boards –interfacing issues with DAS boards, software drivers–data logger –Data acquisition method with time-division channeling and main errors of multi-channel data-acquisition systems, data transmission and error protection					
<b>Module:7 Interfacing</b>					
Bus standard for communication between instruments - GPIB (IEEE-488bus) - RS-232C-USB -4- to-20mA current loop -serial communication systems					

<b>Text Book(s)</b>	
1.	Pallas Areny. R, Webster. J. G, “Sensors and Signal conditioning”, 2nd ed. John Wiley and Sons, 2015
<b>Reference Books</b>	
1.	Jacob Fraden, “Handbook of Modern Sensors: physics, Designs and Applications”, 3rd ed., Springer, 2015.
2.	Taylor, H. Rosemary, “Data Acquisition for Sensor Systems”, Kluwer Academic Publishers Group, 1997.

<b>Course Code</b>	<b>Course Title</b>				
<b>AEL702</b>	<b>Automotive Power Electronics and Motor Drives</b>				
<b>Pre-requisite</b>	<b>Nil</b>				
<b>Course Objectives</b>					
The course is aimed at:					
<ol style="list-style-type: none"> <li>1. Imparting an in-depth knowledge about power electronics devices using MATLAB</li> <li>2. Acquiring the design capability of converters and inverters for the electric and hybrid vehicles</li> <li>3. Gaining knowledge on the different motors and their application in electric vehicles</li> </ol>					
<b>Course Outcome</b>					
At the end of the course, the student will be able to					
<ol style="list-style-type: none"> <li>1. Understand the operation of power semiconductor devices</li> <li>2. Understand the operation of AC-DC converters at different loads</li> <li>3. Understand the operation of three phase inverters</li> <li>4. Design different converters: buck, boost and buck-boost converters</li> <li>5. Understand the concepts of ultracapacitor and its usage in automotive field</li> <li>6. Describe the different speed control methods of induction motors</li> <li>7. Give details about the operation and characteristics of different motors</li> </ol>					
<b>Module:1 Power Electronics</b>					
Introduction to power electronics- Structure , operation and characteristics of automotive semiconductor devices -SCR,Power Transistor, Power MOSFET and IGBT- turn on and off circuits – series and parallel operation of SCR –protection Circuits –design of snubber circuits					
<b>Module:2 Converters</b>					
Half wave controlled converter with R,RL-RLE load, fully controlled converters with R-RL-RLE load-Three phase half wave controlled converter with R-RL load- Three phase fully controlled converter with R-RL load					
<b>Module:3 Inverters</b>					
Voltage source inverter with 120 degree and 180 degree conduction mode-current source inverters – PWM techniques					
<b>Module:4 Choppers</b>					
Step up and step down choppers –Different types of coppers – use of choppers					
<b>Module:5 Ultracapacitors</b>					
Theory of electronic double layer capacitance-model and cell balancing-sizing criteria-converter interface-ultracapacitors in combination with batteries					
<b>Module:6 Automotive motor Control</b>					
Methods of controlling speed – Induction and DC Motor controls					
<b>Module:7 Automotive drive system</b>					
BLDC - Motor construction, characteristics and operation -Open loop and close loop control through speed and current sensors-Switched Reluctance Motor -Motor construction, operation and its application.					
<b>Text Book(s)</b>					

1.	P.S. Bimbhra, “Power Electronics:”, Khanna Publishers, 14th edition, 2015
<b>Reference Books</b>	
1.	Ali Emadi, “Handbook of Automotive power electronics and motor Drives” CRC Press, 2015.
2.	Bimal K Bose, “Power Electronics and Motor Drive: Advances and Trends”, Elsevier, Inc., 2006.

Course Code	Course Title				
AEL703	AUTOSAR and ISO Standards for Automotive Systems				
Pre-requisite	Nil				
<b>Course Objectives</b>					
The course is aimed at:					
<ol style="list-style-type: none"> <li>1. Enabling the students to understand AutoSAR standards</li> <li>2. Introducing to the students the basic knowledge of Communication Stack in AutoSAR</li> <li>3. Preparing the students to understand the implementation and integration in AutoSAR</li> </ol>					
<b>Course Outcome</b>					
At the end of the course, the student will be able to					
<ol style="list-style-type: none"> <li>1. 1. Apply the knowledge of various AutoSAR standards</li> <li>2. 2. Analyze AutoSAR codes</li> <li>3. 3. Apply the AutoSAR – Implementation Integration</li> <li>4. 4. Analyze the AutoSAR – System Services</li> <li>5. Implement CAN programming concepts through AutoSAR</li> <li>6. Analyze the ISO/TS 16949 standards</li> <li>7. Know the implementation aspects of ISO/TS 16949 standards</li> </ol>					
<b>Module:1 AutoSAR Standards</b>					
General requirement on basic software modules – Functional, Fault operation and error detection.					
<b>Module:2 AutoSAR Standards – Communication Stack</b>					
Network Management, TTCAN Interface standards, TTCAN Drivers					
<b>Module:3 AutoSAR – Implementation Integration</b>					
Platform Types, Memory Mapping					
<b>Module:4 AutoSAR – System Services</b>					
Watchdog Manager, Synchronized Time Base Manager					
<b>Module:5 ISO/TS 16949</b>					
Data transmission systems –pulse code format –modulation techniques –telemetry –noise and interference –types and reduction –signal circuit grounding –shield grounding –capacitive, magnetic and optical isolation.					
<b>Module:6 Introduction to ISO26262 Standard: Basic Concepts</b>					
Structure of ISO26262 standard and its parts-Vocabulary-Management of functional Safety-Concept Phase					
<b>Module:7 Introduction to ISO26262 Standard: Implementation Aspects</b>					
Product Development System level-Product Development Hardware level-Product Development Software level-Production and Operation-Supporting Processes-ASIL Oriented and Safety Oriented Analysis-Guidelines on ISO26262 (Informative)-Case Studies to illustrate concepts, Hazard analysis and Risk assessment-Safety Goals, Preliminary Architecture-Functional Safety Concept					
<b>Text Book(s)</b>					
1.	Automotive Quality systems – David Hoyle, Butterworth Heinemann limited, 2015				
<b>Reference Books</b>					

1.	www.autosar.org
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Course Code	Course Title				
AEL704	Alternative Drives, Traction and Controls				
Pre-requisite	MAME505L				
<b>Course Objectives</b>					
The course is aimed at:					
<ol style="list-style-type: none"> <li>1. Acquainting students with the basics of propulsion using IC engines and electric motors</li> <li>2. Knowing about different energy storage and conversion schemes for Hybrid vehicles</li> <li>3. Giving details about the different architectures for Hybrid electric vehicles</li> </ol>					
<b>Course Outcome</b>					
At the end of the course, the students will able to					
<ol style="list-style-type: none"> <li>1. Understand automotive electrical systems</li> <li>2. Suggest an alternate vehicle technology</li> <li>3. Understand the difference in electric motors and IC engines for propulsion in automobiles</li> <li>4. Describe the charging systems for different storages devices</li> <li>5. Understand the types of motors used and control mechanism involved for these types of motors in vehicles</li> <li>6. Explain the various architectures for Hybrid electric vehicles</li> <li>7. Understand the need of fuel cells and use them for hybrid vehicles</li> </ol>					
<b>Module:1 Automotive Electrical Systems</b>					
Electrical Systems and Circuits - Starting systems - Ignition Systems - Lighting & accessories - Electromagnetic Interference and Compatibility					
<b>Module:2 Hybrid Vehicle Technology</b>					
Background on need for alternate vehicle technologies for propulsion - Emissions from IC engine based transportation and regulating standards - Projections on availability of non-renewable energy sources - Alternate technologies for vehicles for reducing urban pollution and for extending availability of resources - Importance of Hybrid Electric Vehicles technology					
<b>Module:3 Basics of Vehicle Propulsion</b>					
Components comprising traction torque - Vehicle performance Parameters – Speed and Acceleration - Fuel economy in IC engine vehicles - Torque – Speed characteristics of IC engines - Comparison of Electric motors and IC engines as vehicle propulsion power sources - Basics of Electric vehicles - Types of Motors and the speed – Torque characteristics					
<b>Module:4 Energy Storage / Energy Conversion</b>					
Different types of Batteries for Electric vehicles - Lead acid batteries, Nickel Metal Hydride Batteries, Lithium ion batteries - Comparison of different types of batteries - Battery Management systems / Energy Management Systems - Wireless Charging Systems - Fast Charging Systems - Super Capacitors - Fuel Cells - Solar Energy Converters.					
<b>Module:5 Motors and Controllers</b>					
DC motors - Principle and control - Induction motor drives - Methods of speed control of Induction motor - Constant V / f control - Vector control method - Inverter for Vector control - Basic principles of BLDC motors - Performance analysis and control of BLDC Motors - Sensor less technique for driving BLDC motors - Regenerative braking with electric drive - Four quadrant operation - Optimizing energy recovery.					
<b>Module:6 Architectures for Hybrid Electric Vehicles</b>					
Series, parallel and series – parallel hybrids - Different architectures for Hybrid Electric vehicles - Series Hybrid Electric vehicle basics - Sizing of major components - Peak power sourcing - Parallel Hybrid electric vehicle basics - Engine on / off control strategy - Peak					

power sourcing - Drive train rating - Parallel Mild hybrid Electric drive system - Series-parallel mild hybrid electric vehicle system.

<b>Module:7</b>	<b>Industry examples of Hybrid Electric Vehicle</b>	
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Fuel cell: Basic principles of fuel cells

**Text Book(s)**

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|----|--|
| 1. | Modern Electric, Hybrid Electric and Fuel cell vehicles - by MehrdadEhsani, Yimin Gao, Sebatien Gay and Ali Emadi; Published by CRC press,2015 |
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**Reference Books**

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|----|---|
| 1. | Iqbal Husain, Electric & Hybrid Vehicles, CRC Press, 2015               |
| 2. | Ronald K Jurgen, Automotive Electronics Handbook, McGraw-Hill Inc. 1999 |

Course Code	Course Title				
<b>AEL705</b>	RTOS in Multi-core Environment				

**Pre-requisite**

**Course Objectives**

The course is aimed at:

1. To introduce concepts of Real Time Operating Systems.
2. To provide insights on Microarchitecture design for Microprocessors.
3. To provide insights on Programming Models for Multicore Architectures.

**Course Outcome**

At the end of the course, the students will able to

1. Ability to understand the features of Real Time Operating Systems.
2. Ability to evaluate the performance of real-time systems.
3. Ability to analyze the architectural design of Microprocessors.
4. Ability to analyze Programming Models for Multicore Systems.

**Module:1**

Real Time Operating System- Introduction to real-time systems - Characteristics and Classification of real-time systems - Features to Real-time Operating Systems - Event and Time Triggered Systems - Tasks and Task States - Processor Utilization Factor - Rate Monotonic, Deadline Monotonic and Earliest Deadline First Scheduling - Response Time Analysis - Processor Demand Analysis - Blocking - Priority Inversion - Priority Inheritance -Priority Ceiling Protocol - Response Time Analysis with Blocking

**Module:2**

Microarchitecture for Multicore- Single-Cycle Processor - Single-Cycle Datapath - Single- Cycle Control - Performance Analysis - Multicycle Processor - Multicycle Datapath - Multicycle Control - Pipelined Processor - Pipelined Datapath - Pipelined Control - Hazards -Advanced Microarchitecture - Deep Pipelines - Micro-Operations - Branch Prediction - Superscalar Processor - Out-of-Order Processor - Register Renaming - Multithreading - Multiprocessors.

**Module:3**

Programming Multicore Architectures - Memory Models - Memory structure of multicore architecture - Cache coherency - Transactional memory - System Virtualization - Hypervisor architectures - Leveraging hardware assists for virtualization - I/O Virtualization - Programming Models for MultiCore - Hybrid Programming with OmpSs - Introduction to AUTOSAR – Layered Software Architecture – Software Components and Ports

**Text Book(s)**

- |    |   |
|----|---|
| 1. | Sarah L. Harri, David Money Harris, <i>Digital Design and Computer Architecture: ARMEdition</i> , Elsevier Inc, 2016. |
|----|---|

2. Sabri Pllana, Fatos Xhafa, *Programming Multicore and Many-core Computing Systems*, Wiley, 2017.

#### Reference Books

1. Donald Norris, *Real World Multicore Embedded Systems*, Elsevier Inc, 2013
2. Hans Hansson, Jan Carlson, Damir Isovich, Kristina Lundqvist, Thomas Nolte, Martin Ouimet, Paul Pettersson, Sasikumar Punnekkat, Cristina Secleanu, *Real-Time Systems*, Fraunhofer IESE 2010.

Course Code	Course Title				
<b>AEL706</b>	<b>Automotive EMI and EMC Standards</b>				
<b>Pre-requisite</b>					
<b>Course Objectives</b>					
The course is aimed at:					
<ol style="list-style-type: none"> <li>1. Teaching the students about the concepts of noise, filter and shield related to EMI and EMC</li> <li>2. Acquainting the students with skills used to build systems compliant with EMC standards</li> <li>3. Providing the students with the knowledge of testing the products for emissions and ESD</li> </ol>					
<b>Course Outcome</b>					
At the end of the course, the student will be able to					
<ol style="list-style-type: none"> <li>1. Comprehend the concepts of power, signal and ground</li> <li>2. Develop and understand the concepts of antennas and transmission lines in EMC</li> <li>3. Understand the concepts of electric, magnetic and electromagnetic fields</li> <li>4. Reproduce the testing methods adopted for conducted and radiated emissions</li> <li>5. Understand the effects of cable and harnessing in EMI and EMC</li> <li>6. Explain about the vehicle generated noise</li> <li>7. Understand the issues of EMC in vehicles and various test methods for ESD</li> </ol>					
<b>Module:1 EMC</b>					
EMC an introduction, System level issues- component and system, significance of EMC, Power and signal return- current path, safety grounding, single point ground					
<b>Module:2 Basic concepts used in EMC</b>					
Antennas, Omni Directional Antennas, Transmission lines, shields, Fourier series, Capacitor, inductor and actual properties, filtering overview, enclosure shielding, shield discontinuities					
<b>Module:3 Electromagnetic Fields</b>					
Introduction, Characteristics of EM environment, comparison of circuit theory and EM field theory, Maxwells equation, Regions around the source, Polarization					
<b>Module:4 EMC testing</b>					
EMC disciplines, Radiated Emission Diagnostics, Switching transients, test methods					
<b>Module:5 Effects of cable and harnessing</b>					
Conducted emission and immunity, Automotive EMC approaches, Filter placement, coupling between wires, Grounding and PCB layout, Ferrites, High frequency emissions					
<b>Module:6 Automobile Electrical and Electronics Systems</b>					
Vehicle generated radiated emissions, Broadband noise, Narrowband noise, Signal characteristics, Vehicle radiated emission tests					
<b>Module:7 EMC issues</b>					
Vehicle ABS, Flight controls, Blimp problems, Fuel systems, Aircraft, Runway wheel chairs, Ignitions sytems, Inexpensive Shielding methods, EMC design for immunity, Automotive industry practices					

<b>Text Book(s)</b>	
1.	Automotive Electromagnetic compatibility – Terence Rybak, Mark steffka – KluverAcademic Publishers, 2015
<b>Reference Books</b>	
1.	Balcells- J.; González- D.; Gago- J. Curso "EMC design in industrial systems". 2015
2.	Weston- D.A. Electromagnetic compatibility: principles and applications. 2nd ed.- rev. and exp. NeYork [etc.]:Marcel Dekker- 2001. ISBN 0824788893

Course Code	Course Title				
AEL707	Vehicular Information and Communication Systems				
Pre-requisite	Nil				
Course Objectives					
The course is aimed at:					
1. Teaching the students concepts of data processing, instrumentation and ECU recording equipment.					
2. Providing students, a good understanding about automotive sound system and navigation for vehicular systems					
3. Providing details about the positioning and guidance systems.					
Course Outcome					
At the end of the course, the student will be able to					
1. Understand the data processing in motor vehicles.					
2. Comprehend the networking in automotive.					
3. Gain knowledge about the information & communication					
4. Understand the ECU recording equipment and Parking systems					
5. Explore the sound system for automotive					
6. Understand the Positioning and Map Matching for vehicles					
7. Understand the Route Planning and Route Guidance techniques for automotive					
Module:1	Data processing in motor vehicles				
Requirements, Electronic control unit (ECU), Architecture, CARTRONIC.					
Module:2	Automotive networking				
Cross-system functions, Requirements for bus systems, Classification of bus systems, Applications in the vehicle, Coupling of networks, Example.					
Module:3	Instrumentation				
Information and communication areas, Driver information systems, Instrument clusters, Display types					
Module:4	ECU recording equipment and Parking systems				
Legal requirements, Design variations, parking aid with ultrasonic sensors, Further development					
Module:5	Automotive sound systems				
Radio tuners, Conventional tuners, Digital receivers, Reception quality, Reception improvement, Auxiliary equipment, Vehicle antennas.					
Module:6	Positioning and Map Matching				
Dead Reckoning, Global Positioning System , Sensor fusion. Conventional map matching, Fuzzy logic Based Map matching, Map aided Sensor calibration.					
Module:7	Route Planning and Route Guidance				
Shortest Path , Heuristic Search, Bidirectional Search , Hierarchical search ,Guidance while En Route , Guidance while off Route , Guidance with dynamic information					
Text Book(s)					
1.	Bosch, “Automotive Handbook”, 8th Edition, SAE publication, 2015				
Reference Books					

1.	Intelligent Vehicle Technologies Theory and Applications–L Vlacic,MParent,FHarashima - Butterworth Heinemann, 2015
2.	Vehicle location and Navigation Systems – Yilin Zhao – Artech House Inc., 2016 Sussman,
3.	Joseph. Perspectives on Intelligent Transportation Systems (ITS). NewYork, 14. NY: Springer, 2010
4.	Mashrur A. Chowdhury, and Adel Sadek, Fundamentals of Intelligent Transportation Systems Planning, Artech House, Inc., 2003

Course Code	Course Title				
AEL708	Parallel Programming using Multi cores and Graphical Programming Units				
Pre-requisite	Nil				
Course Objectives					
The course is aimed at:					
1. Imparting the knowledge about implementation of multi-threading on single core versus multi-core platforms					
2. Providing the basic concept of threads error diffusion and parallel error diffusion.					
3. Elaborating the details of Deadlock and Semaphores and implementation of dependent threading features.					
Course Outcome					
At the end of the course, the student will be able to					
1. Understand the basic concepts of multi-core architecture					
2. Demonstrate knowledge of the core architectural aspects of Parallel Computing					
3. Develop efficient parallel algorithms and apply a suite of techniques that can be applied across a wide range of applications					
4. Apply the concept of threading for large scale systems					
5. Apply methods to support and manage virtualization					
6. Develop and implement the various Parallel Programming Concepts in Linux Platform					
7. Analyze the blockIdx and threadIdx					
Module:1	Multi-core Architecture				
Overview of Single core processor Architecture and its limitations, Architectural Innovations, Need for Multi-core Processor and its Limitations, Classification Multicores, Multicore system software stack.					
Module:2	Overview of Threading				
Defining threads – threads inside the OS – threads inside the hardware – Application programming models and threading – virtual environment – Run time virtualization – System virtualization					
Module:3	Fundamental concepts of parallel programming				
Thread Level Parallelism(TLP), Instruction Level Parallelism(ILP), Comparisons, Cache Hierarchy and Memory-level Parallelism, Cache Coherence, Parallel programming models, Shared Memory and Message Passing, Vectorization					
Module:4	Parallel programming constructs				
Synchronization – Critical sections – Deadlock – Semaphores – Locks – Condition variables – Messages – Fence – Barrier – Implementation dependent threading features					
Module:5	OpenMP : Portable solution for threading				
Loop carried dependence – Data-race conditions – Managing shared and private Data – Loop Scheduling and Partitioning – Effective use of reductions – work-sharing sections – Using barrier and Nowait – Interleaving single thread and multi-thread execution – Data copy-in and copy-out – Protecting updates of shared variables – OpenMP Library functions – OpenMP environmental variables – multithreading debugging techniques					
Module:6	CUDA Programming				

GPUs as Parallel computers – architecture of a modern GPU – Data Parallelism – CUDA program structure – Matrix – Matrix multiplication example – Device memories and data transfer – Kernel functions and threading – predefined variables – Runtime API	
<b>Module:7</b>	<b>CUDA threads and Memories</b>
CUDA thread organization – Using block and thread – synchronization and Transparent Scalability – Thread Assignment – Thread scheduling – CUDA device memory types – strategy for reducing global memory traffic	
<b>Text Book(s)</b>	
1.	Multi-Core Programming, Increasing Performance through Software Multi-threading, Shameem Akhter and Jason Roberts, Intel Press, BPB Publications, New Delhi, 2015
<b>Reference Books</b>	
1.	Programming Massively Parallel Processors, A hands-on approach, David B. Kirk and Wen-mei W. Hwu, Elsevier, New Delhi, 2015

Course Code	Course Title				
AEL709	Digital Signal Processing and its Applications				
Pre-requisite	Nil				
Course Objectives					
The course is aimed at:					
<div><div>1. Introducing the concepts of sampling, digital filter, adaptive digital system</div><div>2. Providing the concepts of information theory and source coding different applications</div><div>3. Teaching methods and algorithms which would enable communication to happen as close to the maximum information transfer rate as possible</div></div>					
Course Outcome					
At the end of the course, the student will be able to					
<div><div>1. Gain insight into digital models and algorithms to process the signals, after due conversion of signals from analog to digital</div><div>2. Determine the techniques to perform analog to digital and digital to analog conversion process</div><div>3. Design adaptive filters based on the signal processing and communication concepts</div><div>4. Analyse the signal spectrum from the received signal and modulation scheme suitable for information transmission</div><div>5. Determine the statistical properties of the signal</div><div>6. Find different ways of minimizing the number of bits, needed to represent a given amount of information</div><div>7. Find methods to minimize the probability of communication errors, without affectingthe rate of communication process</div></div>					
Module:1	Basics				
The history of digital signal processing : Measurements and analysis , Telecommunications, Audio and television, Household appliances and toys, Automotive, Digital signal processing basics: Continuous and discrete signals, Sampling and reconstruction, Quantization, Processing models for discrete-time series, Common filters may be added digital filters: Filter architectures, Filter synthesis, Digital control systems :Proportional-integral-derivate controllers , Advanced controllers					
Module:2	Analog Digital interface				
System considerations : Encoding and modulation, Number representation and companding systems, Digital-to-analog conversion: Multiplying digital-to-analog converters , Integrating digital-to-analog converters, Bitstream digital-to-analog converters , Sample-and-hold and reconstruction filters , Analog-to-digital conversion : Anti-aliasing filters and sample-and-hold , Flash analog-to-digital converters , Successive approximation analog-to-digital converters , Counting analog-to-digital converters , Integrating analog-to-digital converters , Dither , Sigma–delta analog-to-digital converters					

<b>Module:3</b>	<b>Adaptive digital systems</b>	
Introduction: System structure The processor and the performance function: The adaptive linear combiner, The performance function , Adaptation algorithms : The method of steepest descent , Newton's method, The least mean square algorithm , Applications: Adaptiveinterference channel, Equalizers, Adaptive beam forming		
<b>Module:4</b>	<b>Spectral analysis and modulation</b>	
Discrete Fourier transform and fast Fourier transform: Spectral analysis , Discrete Fourier transform and fast Fourier, transform approaches , "Z" transforms Using the auto-correlation function, Periodogram averaging, Parametric spectrum analysis, Modulation : Amplitude shift keying (ASK), Frequency shift keying (FSK), Phase shift keying (PSK), Complex modulation , The Hilbert transformer		
<b>Module:5</b>	<b>Kalman filters</b>	
An intuitive approach : Recursive least square estimation , The pseudo-inverse , TheKalman filter : The signal model , The filter, Kalman filter properties , Applications.		
<b>Module:6</b>	<b>Data compression</b>	
An information theory primer: Information and entropy ,Source coding : Huffman algorithm, Delta modulation, adaptive delta modulation and continuously variable slope delta modulation, DPCM adaptive DPCM techniques, Speech coding, adaptive predictive coding and sub-band coding, Vocoders and linear predictive coding , JPEG, MPEG, MP3, The Lempel–Ziv algorithm, Recognition techniques: Speech recognition, Image recognition		
<b>Module:7</b>	<b>Error-correcting codes</b>	
Channel coding: The channel model , The channel capacity , Error-correcting codes : Hamming distance and error correction , Linear block codes , Cyclic codes, Convolution codes, Viterbi decoding , Interleaving , Concatenated codes and turbo codes		
<b>Text Book(s)</b>		
1.	Digital signal processing and applications, Dag Stranneby and William Walker, Second Edition, Elsevier, New York, 2015	
<b>Reference Books</b>		
1.	Advanced digital signal processing noise reduction, SaeedV.Vasaghi, Fourth edition, Wiley, New Delhi, 2015	
2.	Digital Signal Processing: Fundamentals and Applications, by Li Tan, First edition 2007	

Course Code	Course Title				
AEL710	Open Source Hardware and Software System Design				
Pre-requisite	Nil				
Course Objectives					
The course is aimed at:					
1. Introducing to the students the foundation of open source programming.					
2. Understand client-server architectural model for web applications.					
3. Teaching the students the basis of Automation using Raspberry Pi.					
Course Outcome					
At the end of the course, the student will be able to					
1. Understand the importance of Open Source programming					
2. Identify and apply appropriate server side programming for web based applications					
3. Understand various database operations					
4. Comprehend the operation of different type of Socket programming					
5. Understand the details of Raspberry Pi fundamentals and exploring GPIO Interface					
6. Develop and implement the various Raspberry Pi project					
7. Explore GPIO Interface					
Module:1	Basics				

Variable types – basic operators – decision making – loops – strings- Lists – Tuples – Dictionary – Date and Time – Functions – Modules – Files – Exceptions – Classes and Objects	
<b>Module:2</b>	<b>GUI and Web programming</b>
Tkinter Programming – Tkinter Widgets - CGI – Web server support – Environmental variables – GET and POST methods – Passing information using POST method	
<b>Module:3</b>	<b>Data base access</b>
MySQLdb – database connection – Creating database table – INSERT – READ – UPDATE – DELETE – COMMIT – ROLEBACK	
<b>Module:4</b>	<b>Network Programming</b>
Sockets – Server socket – Client Socket – General Socket methods – Sending an HTTP e-mail – Sending an attachment as an email	
<b>Module:5</b>	<b>Raspberry Pi fundamentals</b>
Architecture – setting up the Raspberry Pi – Interacting with Raspberry command line – Setting up I2C, serial port – Connect Pi to network	
<b>Module:6</b>	<b>Raspberry Basic Projects</b>
Controlling the brightness of LED – Buzzing sound – Switch high power DC source using transistor and relays – controlling high voltage AC device – Using PWM pulses for control – Pi to run different types of motors – servo motor – DC motor – Stepper motor - Displaying HD images – Playing music	
<b>Module:7</b>	<b>Advanced Raspberry projects</b>
Exploring GPIO Interface – Controlling GPIO output – Detecting GPIO input – Work with switches – keypads – Interfacing various sensors – measuring light – detecting methane – measuring acceleration – measuring temperature – measuring distance – logging into a USB flash drive	
<b>Text Book(s)</b>	
1.	Python programming for Raspberry Pi in 24 hours, Richard Blum and Christine Bresnahan, Sams Teach Yourself, Indiana, 2015
<b>Reference Books</b>	
1.	Raspberry Pi Cookbook, Simon Monk, O'Reilly, California, 2015

Course Code	Course Title				
<b>AEL711</b>	<b>Machine Vision System for Automotive</b>				
<b>Pre-requisite</b>	<b>Nil</b>				
<b>Course Objectives</b>					
The course is aimed at:					
<ol style="list-style-type: none"> <li>1. Providing the basic concepts of Digital Image Processing &amp; their algorithm implementation</li> <li>2. Introducing the concepts of shape descriptors and their applications in automotive systems.</li> <li>3. Elaborating on automation and automotive components testing.</li> </ol>					
<b>Course Outcome</b>					
At the end of the course, the student will be able to					
<ol style="list-style-type: none"> <li>1. Understand the principle, advantages, limitation and possible application of image processing in Automotive</li> <li>2. Identify and apply the appropriate image processing techniques to image segmentation, shape analysis and decision making</li> <li>3. Understand the various operational behavior of Components in Automation</li> <li>4. Comprehend the operation of different type of Cylinder blocks, detecting missing balls and behaviours</li> <li>5. Comprehend the concepts of shape description</li> <li>6. Develop and implement vision / manipulator interface</li> <li>7. Detail out automotive component testing techniques</li> </ol>					

<b>Module:1</b>	<b>Elements of Computer Vision</b>
Artificial intelligence – image processing – industrial machine vision – image understanding – System Architecture – Illumination – Sensors - Elementary optics - Camera sensor – Camera interfaces and video standards- Sampling and quantization – inter pixel distances – adjacency conventions – Image acquisition hardware – speed considerations.	
<b>Module:2</b>	<b>Fundamentals of digital Image processing</b>
Point operation – Contrast stretching – thresholding – noise suppression – background subtraction – Neighbourhood operations – Convolution – Thinning – Erosion – dilation – Geometrical operation – Warping – grey level interpolation – registration – morphology – structuring elements – opening and closing – grey scale morphology	
<b>Module:3</b>	<b>Segmentation Problem</b>
Region and boundary based approach – Global, local and dynamic thresholding – Gradient and difference based edge detectors – template matching – region growing - quadtree – boundary detection – graph theoretic techniques – contour following – dynamic programming	
<b>Module:4</b>	<b>Image Analysis</b>
Inspection, location and identification – local template matching – simple feature extraction – classification using Bayes’ rule – Hough transform – Generalized Hough transform – Histogram analysis	
<b>Module:5</b>	<b>Shape description</b>
Taxonomy of shape descriptors – external descriptors – features of the boundary – internal descriptors – features of the region – boundary chain code	
<b>Module:6</b>	<b>Automation considerations</b>
Design of conveyor belts – Choice of various light sources – Design of separators – Grippers – Control of motors – vision / manipulator interface	
<b>Module:7</b>	<b>Automotive component Testing applications</b>
Differentiating types of cylinder blocks – detecting holes in a camshaft – detecting missing balls in bearings – checking faulty components in a car stereo – differentiating gear types detecting a lack of sealing compound – detecting improper assembly of a fuse box – Checking an LCD panel	
<b>Text Book(s)</b>	
1.	Computer and machine vision : Theory, Algorithm and Practicalities, E.R. Davies, Fourth Edition (Kindle Edition), 2015
<b>Reference Books</b>	
1.	Intelligent Vision systems for Industry, Bruce G. Batchelor and Paul F. Whelan, Springer, London, 2015

Course Code	Course Title				
AEL712	Automotive Fault Diagnostics				
Pre-requisite	Nil				
Course Objectives					
The course is aimed at:					
1. Familiarising students with the basic concepts of automotive fault diagnostics					
2. Teaching students about the fault sensors output waveforms					
3. Elaborating the operation of Automotive Oscilloscopes, OBD II and Fault code readers					
Course Outcome					

At the end of the course, the student will be able to	
<ol style="list-style-type: none"> <li>1. Understand the basic concepts of fault diagnosis in automotive field.</li> <li>2. Comprehend MIL for various automotive faults.</li> <li>3. Have a brief idea of various sensors and assess ECU failures with the help of oscilloscope</li> <li>4. Comprehend the operation of fault-finding systems (OBD)</li> <li>5. Identify and rectify the faults of automotive sensors and fuel injection systems.</li> <li>6. Analyze the various failure modes in Electronic control unit of chassis and body units</li> <li>7. Understand the concepts of Electrical systems fault diagnostics</li> </ol>	
<b>Module:1</b>	<b>Diagnostic</b>
Diagnostic Techniques - diagnostic process - diagnostics on paper - mechanical diagnostic techniques - electrical diagnostic techniques - fault codes - on and off-board diagnostics - Data sources	
<b>Module:2</b>	<b>Tools and Equipment</b>
Basic equipment - Oscilloscopes - Scanners - Fault code readers - Engine Analysers	
<b>Module:3</b>	<b>Oscilloscope diagnostics</b>
Sensors - Actuators - Ignition System - Other components	
<b>Module:4</b>	<b>On-board diagnostics</b>
A first perspective - Petrol / Gasoline on-board diagnostics monitors - a second perspective	
<b>Module:5</b>	<b>Engine Systems</b>
Diagnostics of Engine operation - Fuel system - Ignition - Emission - Fuel Injection - Diesel injection - Engine management - Fault finding information - air supply and exhaust systems - cooling - lubrication - batteries - starting system - charging system	
<b>Module:6</b>	<b>Chassis System</b>
Diagnostics of brakes - anti-lock brakes diagnostics - traction control diagnostics - steering and types diagnostics - suspension diagnostics	
<b>Module:7</b>	<b>Electrical System</b>
Electronic components and circuits diagnosis - multiplexing - lighting - diagnosing auxiliary system faults - in car entertainment security and communication - body electrical system faults - diagnosing instruments system faults - HVAC diagnostics - Cruise control diagnostics - Air bags and belt tensions diagnostics	
<b>Text Book(s)</b>	
1. Automotive Technician Training, Tom Denton, Taylor and Francis, New York, 2015	
<b>Reference Books</b>	
1. Automobile Electrical and Electronic Systems : Automotive Technology - Vehicle Maintenance and Repair, Tom Denton, Fourth Edition, Elsevier, New York, 2015	
2. Advanced Automotive Fault Diagnosis: Automotive Technology - Vehicle Maintenance and Repair, Tom Denton, Third Edition, Elsevier, New York, 2012.	

Course Code	Course Title				
AEL713	Emission Control and Diagnosis				
Pre-requisite	Nil				
Course Objectives					
The course is aimed at:					
1. Preparing the students to analyze automotive pollution control techniques					
2. Introducing the concepts of formation and control techniques of pollutants like sulphur, CO, NOx and particulate matter					
3. Preparing the students to analyze smoke for both SI and CI engines					
Course Outcome					

At the end of the course, the student will be able to		
<ol style="list-style-type: none"><li>1. Get details of the emission from automobiles</li><li>2. Analyze emission from Spark Ignition Engine</li><li>3. Analyze emission from Compression Ignition Engine</li><li>4. Explain about the exhaust emissions</li><li>5. Comprehend the Emission Control Legislation - I</li><li>6. Comprehend the Emission Control Legislation – II</li><li>7. Understand about the Exhaust gas measuring techniques</li></ol>		
<b>Module:1</b>	<b>Emission From Automobiles</b>	
8 Sources of Air Pollution. Various emissions from Automobiles — Formation — Effects of pollutants on environment and human beings. Emission control techniques – Modification of fuel, after treatment 11 devices. Emission standards. Automotive waste management, old vehicle disposal, recycling, tyre recycling		
<b>Module:2</b>	<b>Emission From Spark Ignition Engine And Its Control</b>	
Emission formation in SI Engines- Carbon monoxide & Carbon di oxide - Unburned hydrocarbon, NOx, Smoke —Effects of design and operating variables on emission formation – controlling of pollutants - Catalytic converters, Charcoal Canister, CCS, Positive Crank case ventilation system, Secondary air injection, thermal reactor, Laser Assisted Combustion		
<b>Module:3</b>	<b>Emission From Compression Ignition Engine And Its Control</b>	
Formation of White, Blue, and Black Smokes, NOx, soot, sulphur particulate and Intermediate Compounds – Physical and Chemical delay — Significance Effect of Operating variables on Emission formation — Fumigation, Split injection, Catalytic Coating, EGR, HCCI, Particulate Traps, SCR, Fuel additives — Cetane number Effect.		
<b>Module:4</b>	<b>Exhaust Emissions</b>	
Combustion products, Properties of exhaust gas components		
<b>Module:5</b>	<b>Emission control legislation - I</b>	
Overview, CARB legislation, EPA legislation, EU legislation, Japanese legislation		
<b>Module:6</b>	<b>Emission control legislation - II</b>	
US test cycles for passenger cars and light duty trucks, European test cycles for passengercars and light duty trucks, Japanese test cycles for passenger cars and light duty trucks, test cycles for heavy commercial vehicles		
<b>Module:7</b>	<b>Exhaust gas measuring techniques – I</b>	
Exhaust gas test on chassis dynamometers, Exhaust gas measuring devices, Diesel smoke emission test, Evaporative emission test		
<b>Text Book(s)</b>		
1.	G.P.Springer ad D.J.Patterson, Engine Emissions, Pollutant formation, Plenum Press, New York, 1986.	
2.	D.J.Patterson and N.A.Henin, ‘Emission from Combustion Engine and their control’, AnnaArbor Science Publication, 1985.	
3.	Autmotive Handbook – 9th Edition – 2015, BOSCH	
<b>Reference Books</b>		
1.	V.Ganesan, ‘Internal combustion Engines’, Tata McGraw Hill Book Co, Eighth Reprint, 2005.	
2.	Crouse and Anglin, ‘Automotive Emission Control’, McGraw Hill company.,Newyork	
3.	1993. Charles K. Alexander, Matthew N. O. Sadiku, “Fundamentals of Electric Circuits,” 2015, 5th Edition, Tata McGraw Hill Education Private Limited, New Delhi, India.	

Course Code		Course Title			
AEL714		Vehicle Safety Systems			
Pre-requisite		Nil			
Course Objectives					
The course is aimed at:					
1. Have a better understanding of good design practices which will enable product improvement that manifests significantly less risk to humans, machines and the environment					
2. Gain the ability to design and demonstrate the vehicle safety critical systems to reduce the system errors and faults					
3. Introducing the students to do design safety systems using MATLAB simulation					
Course Outcome					
At the end of the course, the student will be able to					
1. Understand the basic concept of vehicle safety					
2. Understand the operation of braking system design and its operation					
3. Understand the braking system for passenger vehicles					
4. Know the working principle of ABS and traction control systems					
5. Understand the concepts of braking systems for commercial vehicles					
6. Understand the vehicle stabilization for commercial vehicles					
7. Understand about the airbag system for passenger safety					
Module:1		Basic concepts of vehicle safety			
Underlying principles-cause and effect –safety factors-design for uncertainty-identifying component safety factor-Digital models and man testing -compliance					
Module:2		Braking systems			
Definitions-principles-design and components of braking system-brake-circuit configurations-braking system design					
Module:3		Braking system for passenger cars and light utility vehicles			
Brake booster-brake master cylinder-braking force limiters-disk brakes-drum brakes					
Module:4		Vehicle stabilization systems for passenger cars			
Anti-Lock braking system(ABS)-traction control system(TCS)-Electronic stabilityprogram(ESP)-Electrohydraulic brakes					
Module:5		Braking system for commercial vehicles			
System and configuration-air supply and processing-Transmission device-wheel brakes-parking brake system-retarder braking system					
Module:6		Vehicle stabilization system for commercial vehicles			
Electronic stability program(ESP) for commercial vehicles-Electronically controlledbraking(ELB)-function-system design-components-electro pneumatic braking					
Module:7		Occupant injury prevention and distracted driver			
Introduction-proper use of head restraints-Airbags-distractors and risk reduction-information processing					
Text Book(s)					
1.	George A. Peters, Barbara J. Peters, "Automotive vehicle safety", Taylor and Francis,3rd edition, 2015				
Reference Books					
1.	Robert Bosch, "Automotive handbook",9th edition,2015				
2.	Bimal K Bose, "Power Electronics and Motor Drive: Advances and Trends", Elsevier, Inc., 2006				

<b>Course Code</b>	<b>Course Title</b>				
<b>AEL715</b>	<b>Vehicle Security and Comfort Systems</b>				
<b>Pre-requisite</b>	<b>Nil</b>				
<b>Course Objectives</b>					
The course is aimed at:					
1. Teaching the students about locking systems and theft-deterrent systems					
2. Providing the technical knowhow of acoustic signalling devices and occupant-protection systems					
3. Discussing about the Power-window drives, comfort and safety functions in the passenger compartment and driver assistance systems					
<b>Course Outcome</b>					
At the end of the course, the student will be able to					
1. Understand about locking systems					
2. Understand the concept of theft-deterrent systems					
3. Understand about the acoustic signalling devices					
4. Demonstrate the knowledge about occupant-protection systems					
5. Brief about power-window drives					
6. Identify the technique for comfort and safety functions in the passenger compartment					
7. Understand about driver-assistance systems					
8. Design and implement vehicle security and comfort systems					
<b>Module:1</b>	<b>Locking systems</b>				
Function, structure, operating principle, Open by wire, Electrical locking system, Central locking system, Electronic vehicle immobilizer, functional description Comfort Entry/Go system					
<b>Module:2</b>	<b>Theft-deterrent systems</b>				
Regulations, Permissible alarm signals. System design, alarm detectors, Alarm system control unit, Alarm siren, Tilt sensor, Interior monitoring					
<b>Module:3</b>	<b>Acoustic signaling devices</b>				
Acoustic signaling devices applications, Horn, Fanfare horns					
<b>Module:4</b>	<b>Occupant-protection systems</b>				
Seat belts and seat-belt pretensioners, Front airbag, Side airbag, Components, Rollover protection systems					
<b>Module:5</b>	<b>Power-window drives</b>				
Power-window motors, Power-window control, Power sunroof drives					
<b>Module:6</b>	<b>Comfort and safety functions in the passenger compartment</b>				
Electrical seat adjustment, Electrical steering-column adjustment, Multi purpose actuator					
<b>Module:7</b>	<b>Driver-assistance systems</b>				
Critical driving situations, Causes of accidents and possible action, Applications, Convenience and safety functions, Sensors for all round electronic visibility, Sensor-data fusion.					
<b>Text Book(s)</b>					
1.	Automotive Handbook – BOSCH – 9th Edition -2015				
<b>Reference Books</b>					
1.	Bosch, "Safety, Comfort & Convenience Systems" 7th Edition - 2016				

## M.Tech in Automotive Electronics

### Audit Courses:

#### ACL701: ENGLISH FOR RESEARCH PAPER WRITING

**Course objectives:**

Students will be able to:

1. Understand that how to improve your writing skills and level of readability
2. Learn about what to write in each section
3. Understand the skills needed when writing a Title
4. Ensure the good quality of paper at very first-time submission

**Syllabus**

Units	CONTENTS	
1	Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness	
2	Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticising, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts. Introduction	
3	Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check.	
4	key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature,	
5	skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions	
6	useful phrases, how to ensure paper is as good as it could possibly be the first-time submission	

**Suggested Studies:**

1. Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books)
2. Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press
3. Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM. Highman's book.
4. Adrian Wallwork, English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011

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### ACL702: DISASTER MANAGEMENT

**Course Objectives:** -Students will be able to:

1. learn to demonstrate a critical understanding of key concepts in disaster risk reduction and humanitarian response.
2. critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
3. develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
4. critically understand the strengths and weaknesses of disaster management approaches, planning and programming in different countries, particularly their home country or the countries they work in

Syllabus		
Units	CONTENTS	
1	<b>Introduction</b> Disaster: Definition, Factors And Significance; Difference Between Hazard And Disaster; Natural And Manmade Disasters: Difference, Nature, Types And Magnitude.	
2	<b>Repercussions Of Disasters And Hazards:</b> Economic Damage, Loss Of Human And Animal Life, Destruction Of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.	
3	<b>Disaster Prone Areas In India</b> Study Of Seismic Zones; Areas Prone To Floods And Droughts, Landslides And Avalanches; Areas Prone To Cyclonic And Coastal Hazards With Special Reference To Tsunami; Post-Disaster Diseases And Epidemics	
4	<b>Disaster Preparedness And Management</b> Preparedness: Monitoring Of Phenomena Triggering A Disaster Or Hazard; Evaluation Of Risk: Application Of Remote Sensing, Data From Meteorological And Other Agencies, Media Reports: Governmental And Community Preparedness.	
5	<b>Risk Assessment</b> Disaster Risk: Concept And Elements, Disaster Risk Reduction, Global And National Disaster Risk Situation. Techniques Of Risk Assessment, Global Co-Operation In Risk Assessment And Warning, People's Participation In Risk Assessment. Strategies for Survival.	
6	<b>Disaster Mitigation</b> Meaning, Concept And Strategies Of Disaster Mitigation, Emerging Trends In Mitigation. Structural Mitigation And Non-Structural Mitigation, Programs Of Disaster Mitigation In India.	

### SUGGESTED READINGS:

1. R. Nishith, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "New Royal book Company.
2. Sahni, PardeepEt.Al. (Eds.), " Disaster Mitigation Experiences And Reflections", Prentice Hall Of India, New Delhi.

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3. Goel S. L., Disaster Administration And Management Text And Case Studies”, Deep & Deep Publication Pvt. Ltd., New Delhi.

### ACL703: SANSKRIT FOR TECHNICAL KNOWLEDGE

#### Course Objectives

1. To get a working knowledge in illustrious Sanskrit, the scientific language in the world
2. Learning of Sanskrit to improve brain functioning
3. Learning of Sanskrit to develop the logic in mathematics, science & other subjects
4. enhancing the memory power
5. The engineering scholars equipped with Sanskrit will be able to explore the
6. huge knowledge from ancient literature

#### Syllabus

Unit	Content	
1	<ul style="list-style-type: none"><li>• Alphabets in Sanskrit,</li><li>• Past/Present/Future Tense,</li><li>• Simple Sentences</li></ul>	
2	<ul style="list-style-type: none"><li>• Order</li><li>• Introduction of roots</li><li>• Technical information about Sanskrit Literature</li></ul>	
3	<ul style="list-style-type: none"><li>• Technical concepts of Engineering-Electrical, Mechanical,</li><li>• Architecture, Mathematics</li></ul>	

#### Suggested reading

1. “Abhyaspustakam” – Dr.Vishwas, Samskrita-Bharti Publication, New Delhi
2. “Teach Yourself Sanskrit” Prathama Deeksha-VempatiKutumbshastri, Rashtriya Sanskrit Sansthanam, New Delhi Publication
3. “India’s Glorious Scientific Tradition” Suresh Soni, Ocean books (P) Ltd., New Delhi.

#### Course Output

Students will be able to

1. Understanding basic Sanskrit language
2. Ancient Sanskrit literature about science & technology can be understood
3. Being a logical language will help to develop logic in students

### ACL704: VALUE EDUCATION

#### Course Objectives

Students will be able to

1. Understand value of education and self- development
2. Imbibe good values in students
3. Let the should know about the importance of character

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### Syllabus

Units	CONTENTS	
1	<ul style="list-style-type: none"><li>• Values and self-development – Social values and individual attitudes.</li><li>• Work ethics, Indian vision of humanism.</li><li>• Moral and non-moral valuation. Standards and principles.</li><li>• Value judgments.</li></ul>	
2	<ul style="list-style-type: none"><li>• Importance of cultivation of values.</li><li>• Sense of duty. Devotion, Self-reliance. Confidence, Concentration. Truthfulness, Cleanliness.</li><li>• Honesty, Humanity. Power of faith, National Unity.</li><li>• Patriotism. Love for nature, Discipline.</li></ul>	
3	<ul style="list-style-type: none"><li>• Personality and Behavior Development - Soul and Scientific attitude. Positive Thinking. Integrity and discipline.</li><li>• Punctuality, Love and Kindness.</li><li>• Avoid fault Thinking.</li><li>• Free from anger, Dignity of labor.</li><li>• Universal brotherhood and religious tolerance.</li><li>• True friendship.</li><li>• Happiness Vs suffering, love for truth.</li><li>• Aware of self-destructive habits.</li><li>• Association and Cooperation.</li><li>• Doing best for saving nature</li></ul>	
4	<ul style="list-style-type: none"><li>• Character and Competence – Holy books vs Blind faith.</li><li>• Self-management and Good health.</li><li>• Science of reincarnation.</li><li>• Equality, Nonviolence, Humility, Role of Women.</li><li>• All religions and same message.</li><li>• Mind your Mind, Self-control.</li><li>• Honesty, Studying effectively</li></ul>	

### Suggested reading

1. Chakroborty, S.K. "Values and Ethics for organizations Theory and practice", Oxford University Press, New Delhi

### Course outcomes

Students will be able to

1. Knowledge of self-development
2. Learn the importance of Human values
3. Developing the overall personality

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### ACL705: CONSTITUTION OF INDIA

#### Course Objectives:

Students will be able to:

1. Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
2. To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional role and entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism.
3. To address the role of socialism in India after the commencement of the Bolshevik Revolution in 1917 and its impact on the initial drafting of the Indian Constitution.

#### Syllabus

Units	Content	
1	<b>□ History of Making of the Indian Constitution:</b> History Drafting Committee, ( Composition & Working)	
2	<b>□ Philosophy of the Indian Constitution:</b> Preamble Salient Features	
3	<b>• Contours of Constitutional Rights &amp; Duties:</b> • Fundamental Rights • Right to Equality • Right to Freedom • Right against Exploitation • Right to Freedom of Religion • Cultural and Educational Rights • Right to Constitutional Remedies □ Directive Principles of State Policy • Fundamental Duties.	
4	<b>• Organs of Governance:</b> • Parliament • Composition • Qualifications and Disqualifications • Powers and Functions • Executive • President • Governor • Council of Ministers • Judiciary, Appointment and Transfer of Judges, Qualifications • Powers and Functions	

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5	<ul style="list-style-type: none"><li>• <b>Local Administration:</b></li><li>• District's Administration head: Role and Importance,</li><li>• Municipalities: Introduction, Mayor and role of Elected Representative CEO of Municipal Corporation.</li><li>• Pachayati raj: Introduction, PRI: ZilaPachayat.</li><li>• Elected officials and their roles, CEO ZilaPachayat: Position and role.</li><li>• Block level: Organizational Hierarchy (Different departments),</li><li>• Village level: Role of Elected and Appointed officials,</li><li>• Importance of grass root democracy</li></ul>	
6	<ul style="list-style-type: none"><li>• <b>Election Commission:</b></li><li>• Election Commission: Role and Functioning.</li><li>• Chief Election Commissioner and Election Commissioners.</li><li>• State Election Commission: Role and Functioning.</li><li>• Institute and Bodies for the welfare of SC/ST/OBC and women.</li></ul>	

### Suggested reading

1. The Constitution of India, 1950 (Bare Act), Government Publication.
2. Dr. S. N. Busi, Dr. B. R. Ambedkar framing of Indian Constitution, 1st Edition, 2015.
3. M. P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis, 2014.
4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

### Course Outcomes:

#### Students will be able to:

1. Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
2. Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.
3. Discuss the circumstances surrounding the foundation of the Congress Socialist Party [CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.
4. Discuss the passage of the Hindu Code Bill of 1956.

### ACL706: PEDAGOGY STUDIES

#### Course Objectives:

Students will be able to:

1. Review existing evidence on the review topic to inform programme design and policy making undertaken by the DfID, other agencies and researchers.
2. Identify critical evidence gaps to guide the development.

Syllabus		
Units	Content	

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<b>1</b>	<ul style="list-style-type: none"> <li>• <b>Introduction and Methodology:</b></li> <li>• Aims and rationale, Policy background, Conceptual framework and terminology</li> <li>• Theories of learning, Curriculum, Teacher education.</li> <li>• Conceptual framework, Research questions.</li> <li>• Overview of methodology and Searching.</li> </ul>	
<b>2</b>	<ul style="list-style-type: none"> <li>• Thematic overview: Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries.</li> <li>• Curriculum, Teacher education.</li> </ul>	
<b>3</b>	<ul style="list-style-type: none"> <li>• Evidence on the effectiveness of pedagogical practices</li> <li>• Methodology for the in depth stage: quality assessment of included studies.</li> <li>• How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy?</li> <li>• Theory of change.</li> <li>• Strength and nature of the body of evidence for effective pedagogical practices.</li> <li>• Pedagogic theory and pedagogical approaches.</li> <li>• Teachers' attitudes and beliefs and Pedagogic strategies.</li> </ul>	
<b>4</b>	<ul style="list-style-type: none"> <li>• Professional development: alignment with classroom practices and follow-up support</li> <li>• Peer support</li> <li>• Support from the head teacher and the community.</li> <li>• Curriculum and assessment</li> <li>• Barriers to learning: limited resources and large class sizes</li> </ul>	
<b>5</b>	<ul style="list-style-type: none"> <li>• <b>Research gaps and future directions</b></li> <li>• Research design</li> <li>• Contexts</li> </ul>	
	<ul style="list-style-type: none"> <li>• Pedagogy</li> <li>• Teacher education</li> <li>• Curriculum and assessment</li> <li>• Dissemination and research impact.</li> </ul>	

### Suggested reading

1. Ackers J, Hardman F (2001) Classroom interaction in Kenyan primary schools, Compare, 31 (2): 245-261.
2. Agrawal M (2004) Curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36 (3): 361-379.
3. Akyeampong K (2003) Teacher training in Ghana - does it count? Multi-site teacher education research project (MUSTER) country report 1. London: DFID.
4. Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count? International Journal Educational Development, 33 (3): 272-282.
5. Alexander RJ (2001) Culture and pedagogy: International comparisons in primary education. Oxford and Boston: Blackwell.
6. Chavan M (2003) Read India: A mass scale, rapid, 'learning to read' campaign.

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7. [www.pratham.org/images/resource%20working%20paper%202.pdf](http://www.pratham.org/images/resource%20working%20paper%202.pdf).

### Course Outcomes

Students will be able to understand:

1. What pedagogical practices are being used by teachers in formal and informal classrooms in developing countries?
2. What is the evidence on the effectiveness of these pedagogical practices, in what conditions, and with what population of learners?
3. How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy?

### ACL707: STRESS MANAGEMENT BY YOGA

#### Course Objectives

1. To achieve overall health of body and mind
2. To overcome stress

#### Syllabus

Unit	Content	
1	□ Definitions of Eight parts of yog. ( Ashtanga )	
2	□ Yam and Niyam. Do's and Don't's in life. i) Ahinsa, satya, astheya, bramhacharya and aparigraha ii) Shaucha, santosh, tapa, swadhyay, ishwarpranidhan	
3	□ Asan and Pranayam i) Various yog poses and their benefits for mind & body ii) Regularization of breathing techniques and its effects- Types of pranayam	

#### Suggested reading

1. 'Yogic Asanas for Group Training-Part-I' :Janardan Swami Yogabhyasi Mandal, Nagpur
2. "Rajayoga or conquering the Internal Nature" by Swami Vivekananda, Advaita Ashrama (Publication Department), Kolkata

### Course Outcomes:

Students will be able to:

1. Develop healthy mind in a healthy body thus improving social health also
2. Improve efficiency

### ACL708: PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS

#### Course Objectives

1. To learn to achieve the highest goal happily
2. To become a person with stable mind, pleasing personality and determination
3. To awaken wisdom in students

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### Syllabus

Unit	Content	
1	Neetisatakam-Holistic development of personality <ul style="list-style-type: none"><li>• Verses- 19,20,21,22 (wisdom)</li><li>• Verses- 29,31,32 (pride &amp; heroism)</li><li>• Verses- 26,28,63,65 (virtue)</li><li>• Verses- 52,53,59 (don't's)</li><li>• Verses- 71,73,75,78 (do's)</li></ul>	
2	<ul style="list-style-type: none"><li>• Approach to day to day work and duties.</li><li>• Shrimad BhagwadGeeta : Chapter 2-Verses 41, 47,48,</li><li>• Chapter 3-Verses 13, 21, 27, 35, Chapter 6-Verses 5,13,17, 23, 35,</li><li>• Chapter 18-Verses 45, 46, 48.</li></ul>	
3	<ul style="list-style-type: none"><li>• Statements of basic knowledge.</li><li>• Shrimad BhagwadGeeta: Chapter2-Verses 56, 62, 68</li><li>• Chapter 12 -Verses 13, 14, 15, 16,17, 18</li><li>• Personality of Role model. Shrimad BhagwadGeeta: Chapter2-Verses 17, Chapter 3-Verses 36,37,42,</li><li>• Chapter 4-Verses 18, 38,39</li><li>• Chapter18 – Verses 37,38,63</li></ul>	

### Suggested reading

1. "Srimad Bhagavad Gita" by Swami SwarupanandaAdvaita Ashram (Publication Department), Kolkata
3. Bhartrihari's Three Satakam (Niti-sringar-vairagya) by P.Gopinath,
4. Rashtriya Sanskrit Sansthanam, New Delhi.

### Course Outcomes

Students will be able to

1. Study of Shrimad-Bhagwad-Geeta will help the student in developing his personality and achieve the highest goal in life
2. The person who has studied Geeta will lead the nation and mankind to peace and prosperity
3. Study of Neetishatakam will help in developing versatile personality of students.

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### Open Elective Subjects:

#### Business Analytics

#### Teaching scheme

Course Code	
Course Name	Business Analytics

<b>Course objective</b>
<ol style="list-style-type: none"><li>1. Understand the role of business analytics within an organization.</li><li>2. Analyze data using statistical and data mining techniques and understand relationships between the underlying business processes of an organization.</li><li>3. To gain an understanding of how managers use business analytics to formulate and solve business problems and to support managerial decision making.</li><li>4. To become familiar with processes needed to develop, report, and analyze business data.</li><li>5. Use decision-making tools/Operations research techniques.</li><li>6. Mange business process using analytical and management tools.</li><li>7. Analyze and solve problems from different industries such as manufacturing, service, retail, software, banking and finance, sports, pharmaceutical, aerospace etc.</li></ol>

<b>LECTURE WITH BREAKUP</b>	
<b>Unit1:</b> Business analytics: Overview of Business analytics, Scope of Business analytics, Business Analytics Process, Relationship of Business Analytics Process and organisation, competitive advantages of Business Analytics. Statistical Tools: Statistical Notation, Descriptive Statistical methods, Review of probability distribution and data modelling, sampling and estimation methods overview.	
<b>Unit 2:</b> Trendiness and Regression Analysis: Modelling Relationships and Trends in Data, simple Linear Regression. Important Resources, Business Analytics Personnel, Data and models for Business analytics, problem solving, Visualizing and Exploring Data, Business Analytics Technology.	
<b>Unit 3:</b> Organization Structures of Business analytics, Team management, Management Issues, Designing Information Policy, Outsourcing, Ensuring Data Quality, Measuring contribution of Business analytics, Managing Changes. Descriptive Analytics, predictive analytics, predicative Modelling, Predictive	

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analytics analysis, Data Mining, Data Mining Methodologies, Prescriptive analytics and its step in the business analytics Process, Prescriptive Modelling, nonlinear Optimization.	
<b>Unit 4:</b> Forecasting Techniques: Qualitative and Judgmental Forecasting, Statistical Forecasting Models, Forecasting Models for Stationary Time Series, Forecasting Models for Time Series with a Linear Trend, Forecasting Time Series with Seasonality, Regression Forecasting with Casual Variables, Selecting Appropriate Forecasting Models.  Monte Carlo Simulation and Risk Analysis: Monte Carle Simulation Using Analytic Solver Platform, New-Product Development Model, Newsvendor Model, Overbooking Model, Cash Budget Model.	
<b>Unit 5:</b> Decision Analysis: Formulating Decision Problems, Decision Strategies with the without Outcome Probabilities, Decision Trees, The Value of Information, Utility and Decision Making.	
<b>Unit 6:</b> Recent Trends in : Embedded and collaborative business intelligence, Visual data recovery, Data Storytelling and Data journalism.	

### COURSE OUTCOMES

1. Students will demonstrate knowledge of data analytics.
2. Students will demonstrate the ability of think critically in making decisions based on data and deep analytics.
3. Students will demonstrate the ability to use technical skills in predicative and prescriptive modeling to support business decision-making.
4. Students will demonstrate the ability to translate data into clear, actionable insights.

### Reference:

1. Business analytics Principles, Concepts, and Applications by Marc J. Schniederjans, Dara G. Schniederjans, Christopher M. Starkey, Pearson FT Press.
2. Business Analytics by James Evans, persons Education.

### Industrial Safety

#### Teaching scheme

**Unit-I:** Industrial safety: Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes. Fire prevention and firefighting, equipment and methods.

**Unit-II:** Fundamentals of maintenance engineering: Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.

**Unit-III:** Wear and Corrosion and their prevention: Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and

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applications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, Definition, principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods.

**Unit-IV:** Fault tracing: Fault tracing-concept and importance, decision tree concept, need and applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment's like, I. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler, vi. Electrical motors, Types of faults in machine tools and their general causes.

**Unit-V:** Periodic and preventive maintenance: Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of: I. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance **Reference:**

1. Maintenance Engineering Handbook, Higgins & Morrow, Da Information Services.
2. Maintenance Engineering, H. P. Garg, S. Chand and Company.
3. Pump-hydraulic Compressors, Audels, McGraw Hill Publication.
4. Foundation Engineering Handbook, Winterkorn, Hans, Chapman & Hall London.

### OPEN ELECTIVES Operations Research

#### Teaching Scheme

**Course Outcomes:** At the end of the course, the student should be able to

1. Students should able to apply the dynamic programming to solve problems of discrete and continuous variables.
2. Students should able to apply the concept of non-linear programming
3. Students should able to carry out sensitivity analysis
4. Student should able to model the real world problem and simulate it.

#### Syllabus Contents:

##### Unit 1:

Optimization Techniques, Model Formulation, models, General L.R Formulation, Simplex

Techniques, Sensitivity Analysis, Inventory Control

##### Models Unit 2

Formulation of a LPP - Graphical solution revised simplex method - duality theory - dual simplex method - sensitivity analysis - parametric programming

##### Unit 3:

Nonlinear programming problem - Kuhn-Tucker conditions min cost flow problem - max flow problem - CPM/PERT

##### Unit 4

Scheduling and sequencing - single server and multiple server models - deterministic inventory models - Probabilistic inventory control models - Geometric Programming.

##### Unit 5

Competitive Models, Single and Multi-channel Problems, Sequencing Models, Dynamic

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Programming, Flow in Networks, Elementary Graph Theory, Game Theory Simulation

### **References:**

1. H.A. Taha, Operations Research, An Introduction, PHI, 2008
2. H.M. Wagner, Principles of Operations Research, PHI, Delhi, 1982.
3. J.C. Pant, Introduction to Optimisation: Operations Research, Jain Brothers, Delhi, 2008
4. Hitler Libermann Operations Research: McGraw Hill Pub. 2009
5. Pannerselvam, Operations Research: Prentice Hall of India 2010
6. Harvey M Wagner, Principles of Operations Research: Prentice Hall of India 2010

### **Cost Management of Engineering Projects**

#### **Teaching scheme**

Introduction and Overview of the Strategic Cost Management Process

Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunity cost. Objectives of a Costing System; Inventory valuation; Creation of a Database for operational control; Provision of data for Decision-Making.

Project: meaning, Different types, why to manage, cost overruns centres, various stages of project execution: conception to commissioning. Project execution as conglomeration of technical and nontechnical activities. Detailed Engineering activities. Pre project execution main clearances and documents Project team: Role of each member. Importance Project site: Data required with significance. Project contracts. Types and contents. Project execution Project cost control. Bar charts and Network diagram. Project commissioning: mechanical and process

Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis. Various decision-making problems. Standard Costing and Variance Analysis. Pricing strategies: Pareto Analysis. Target costing, Life Cycle Costing. Costing of service sector. Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Total Quality Management and Theory of constraints. Activity-Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis. Budgetary Control; Flexible Budgets; Performance budgets; Zero-based budgets. Measurement of Divisional profitability pricing decisions including transfer pricing.

Quantitative techniques for cost management, Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Simulation, Learning Curve Theory.

### **References:**

1. Cost Accounting A Managerial Emphasis, Prentice Hall of India, New Delhi
2. Charles T. Horngren and George Foster, Advanced Management Accounting
3. Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting
4. Ashish K. Bhattacharya, Principles & Practices of Cost Accounting A. H. Wheeler publisher
5. N.D. Vohra, Quantitative Techniques in Management, Tata McGraw Hill Book Co. Ltd.

### **Composite Materials**

#### **Teaching scheme**

**UNIT-I: INTRODUCTION:** Definition – Classification and characteristics of Composite materials. Advantages and application of composites. Functional requirements of reinforcement

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and matrix. Effect of reinforcement (size, shape, distribution, volume fraction) on overall composite performance.

**UNIT – II: REINFORCEMENTS:** Preparation-layup, curing, properties and applications of glass fibers, carbon fibers, Kevlar fibers and Boron fibers. Properties and applications of whiskers, particle reinforcements. Mechanical Behavior of composites: Rule of mixtures, Inverse rule of mixtures. Isostrain and Isostress conditions.

**UNIT – III:** Manufacturing of Metal Matrix Composites: Casting – Solid State diffusion technique, Cladding – Hot isostatic pressing. Properties and applications. Manufacturing of Ceramic Matrix Composites: Liquid Metal Infiltration – Liquid phase sintering. Manufacturing of Carbon – Carbon composites: Knitting, Braiding, Weaving. Properties and applications.

**UNIT–IV:** Manufacturing of Polymer Matrix Composites: Preparation of Moulding compounds and prepregs – hand layup method – Autoclave method – Filament winding method – Compression moulding – Reaction injection moulding. Properties and applications.

**UNIT – V:** Strength: Laminar Failure Criteria-strength ratio, maximum stress criteria, maximum strain criteria, interacting failure criteria, hygrothermal failure. Laminate first ply failure-insight strength; Laminate strength-ply discount truncated maximum strain criterion; strength design using caplet plots; stress concentrations.

### TEXT BOOKS:

1. Material Science and Technology – Vol 13 – Composites by R.W.Cahn – VCH, West Germany.
2. Materials Science and Engineering, An introduction. WD Callister, Jr., Adapted by R. Balasubramaniam, John Wiley & Sons, NY, Indian edition, 2007.

### References:

1. Hand Book of Composite Materials-ed-Lubin.
2. Composite Materials – K.K.Chawla.
3. Composite Materials Science and Applications – Deborah D.L. Chung.
4. Composite Materials Design and Applications – Danial Gay, Suong V. Hoa, and Stephen W. Tasi.

## Waste to Energy

### Teaching scheme

**Unit-I:** Introduction to Energy from Waste: Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digestors

**Unit-II:** Biomass Pyrolysis: Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods - Yields and application – Manufacture of pyrolytic oils and gases, yields and applications.

**Unit-III:** Biomass Gasification: Gasifiers – Fixed bed system – Downdraft and updraft gasifiers – Fluidized bed gasifiers – Design, construction and operation – Gasifier burner arrangement for thermal heating – Gasifier engine arrangement and electrical power – Equilibrium and kinetic consideration in gasifier operation.

**Unit-IV:** Biomass Combustion: Biomass stoves – Improved chullahs, types, some exotic designs, Fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation - Operation of all the above biomass combustors.

**Unit-V:** Biogas: Properties of biogas (Calorific value and composition) - Biogas plant technology and status - Bio energy system - Design and constructional features - Biomass resources and their classification - Biomass conversion processes - Thermo chemical conversion - Direct combustion - biomass gasification - pyrolysis and liquefaction - biochemical conversion - anaerobic digestion

## **M.Tech in Automotive Electronics**

- Types of biogas Plants – Applications - Alcohol production from biomass - Bio diesel production
- Urban waste to energy conversion - Biomass energy programme in India. **References:**

1. Non Conventional Energy, Desai, Ashok V., Wiley Eastern Ltd., 1990.
2. Biogas Technology - A Practical Hand Book - Khandelwal, K. C. and Mahdi, S. S., Vol. I & II, Tata McGraw Hill Publishing Co. Ltd., 1983.
3. Food, Feed and Fuel from Biomass, Challal, D. S., IBH Publishing Co. Pvt. Ltd., 1991.
4. Biomass Conversion and Technology, C. Y. WereKo-Brobby and E. B. Hagan, John Wiley & Sons, 1996.