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**AUTOMOTIVE ELECTRICAL AND ELECTRONIC SYSTEM** **Course Code : 316009**

**Programme Name/s** : **Automobile Engineering.**

**Programme Code** : **AE**

**Semester** : **Sixth**

**Course Title** : **AUTOMOTIVE ELECTRICAL AND ELECTRONIC SYSTEM**

**Course Code** : **316009**

## I. RATIONALE

Modern vehicles are equipped with a variety of electrical, electronic, and computer-controlled systems that play a crucial role in enhancing performance, drivability, and safety. These systems are managed by multiple control units to ensure optimal efficiency and functionality. Diploma holders in automobile engineering are expected to identify electrical, electronic and computer controlled system components and demonstrate diagnosis thereof. This course is designed to provide students with the essential skills needed to maintain and troubleshoot these advanced systems, preparing them for the demands of automobile industry.

## II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

The aim of this course is to help the students to attain the following industry identified outcome through various teaching learning experiences: Maintain automotive electrical and electronic systems efficiently and safely.

## III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Test components of automotive electrical and electronic circuits.
- CO2 - Test automotive batteries and charging system.
- CO3 - Test cranking system and ignition system.
- CO4 - Troubleshoot automotive transducers and OBD-II systems.

## IV. TEACHING-LEARNING & ASSESSMENT SCHEME

| Course Code | Course Title | Abbr | Course Category/s | Learning Scheme | | | | | Credits | Assessment Scheme | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Actual Contact Hrs./ Week | | | SLH | NLH | | Paper Duration | Theory | | | | Based on LL & TL | | | | Based on SL | | Total Marks |
| | | | | | | | | | | | | | | | Practical | | | | | | |
| | | | | CL | TL | LL | | | | | FA-TH | SA-TH | Total | | FA-PR | | SA-PR | | SLA | | |
| | | | | | | | | | | | Max | Max | Max | Min | Max | Min | Max | Min | Max | Min | |
| 316009 | AUTOMOTIVE ELECTRICAL AND ELECTRONIC SYSTEM | AES | AEC | 2 | - | 2 | - | 4 | 2 | - | - | - | - | - | 25 | 10 | 50@ | 20 | - | - | 75 |

**Total IKS Hrs for Sem. :** 0 Hrs

Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment

Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination

Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.

7. * Self learning includes micro project / assignment / other activities.

## V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

| Sr.No | Theory Learning Outcomes (TLO's)aligned to CO's. | Learning content mapped with Theory Learning Outcomes (TLO's) and CO's. | Suggested Learning Pedagogies. |
|---|---|---|---|
| 1 | TLO 1.1 State the function of electrical components in the given circuit.<br>TLO 1.2 Describe the operation of the given circuit protection device.<br>TLO 1.3 Describe the test procedure of the given circuit.<br>TLO 1.4 Describe the impact of integrating a smart wiring harness with Flexible Data-rate Controller Area Network (CAN-FD) on modern vehicles. | **Unit - I Electrical Components, Circuit Protection Devices, and Smart Wiring Systems**<br>1.1 Purpose and operation of electrical components and circuit protection devices. a)Switches: Single Pole Single Throw (SPST), Single Pole Double Throw (SPDT), Ganged switch. b)Relays, Solenoids, Buzzers, Resistors. c)Fuses, Maxi fuses, Fusible links, Smart fuses and circuit breakers with self-resetting capabilities.<br>1.2 Testing of circuit defects: Open circuit, short circuit, short to ground, voltage drop.<br>1.3 Smart Wiring Harness & Flexible Data-rate Controller Area Network (CAN-FD) – Evolution from traditional wiring harness to high-speed communication networks.<br>1.4 Wiring diagrams: Headlight, turn indicators, Horn, Windshield wiper, Stop light. | Lecture Using Chalk-Board<br>Video Demonstrations<br>Model Demonstration |
| 2 | TLO 2.1 Describe working of the given type of battery.<br>TLO 2.2 List the causes of battery failure based on given symptoms.<br>TLO 2.3 Explain working of Computer/ ECM -controlled alternator.<br>TLO 2.4 Explain working of the computer controlled charging system. | **Unit - II Automotive Batteries and Charging System**<br>2.1 Battery: Types of Battery, Construction and Working of following types: Lead acid battery, Maintenance free battery, Hybrid Battery, Lithium-ion battery, Battery rating and specifications.<br>2.2 Standard procedure of battery charging.<br>2.3 Battery failure: Types and causes<br>2.4 Charging system: Charging system circuit, Alternator – Principle of working, Construction and working, Computer/ Electronic Control Module (ECM) controlled alternator. | Lecture Using Chalk-Board<br>Video Demonstrations<br>Model Demonstration |
| 3 | TLO 3.1 Describe working of the given cranking system aggregates.<br>TLO 3.2 State remedial measures for starting system trouble with justification.<br>TLO 3.3 Explain working of the computer-controlled ignition system. | **Unit - III Cranking and Ignition System**<br>3.1 Cranking system: solenoid-operated starter circuit, components and their functions.<br>3.2 Types of starter drive: overrunning clutch and Integrated Starter Generator (ISG) system. Stop-Start System: components and working.<br>3.3 Computer-controlled cranking system.<br>3.4 Starter motor components, working principle.<br>3.5 Cranking system: Symptoms and troubleshooting.<br>3.6 Computer controlled ignition system: operation with block diagram. | Lecture Using Chalk-Board<br>Video Demonstrations<br>Model Demonstration |
| 4 | TLO 4.1 Describe working of the given transducer on engine.<br>TLO 4.2 Describe testing procedure of the given transducer.<br>TLO 4.3 Describe diagnosis procedure of the given sensors using scan tool. | **Unit - IV Automotive Transducers and On Board Diagnostics (OBD) -II System**<br>4.1 Transducers - construction, working: Camshaft position sensor, Coolant temperature sensor, Throttle position sensor, Oxygen sensor, Manifold absolute pressure sensor, Mass air flow sensor, electronic fuel injector, idle air control valve.<br>4.2 OBD II procedure for body computer and relevant transducers: Function, diagnosis and procedure to erase fault code. | Video Demonstrations<br>Demonstration<br>Site/Industry Visit<br>Flipped Classroom |

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## VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

| Practical / Tutorial / Laboratory Learning Outcome (LLO) | Sr No | Laboratory Experiment / Practical Titles / Tutorial Titles | Number of hrs. | Relevant COs |
|---|---|---|---|---|
| LLO 1.1 Inspect given electrical/ electronic component using multi meter.<br>LLO 1.2 Inspect given circuit protection device. | 1 | *Electrical components and circuit protection devices. | 2 | CO1 |
| LLO 2.1 Diagnose given parallel/ series circuit fault using service manual standard procedure.<br>LLO 2.2 Troubleshoot fault in wiring harness. | 2 | Troubleshooting of the faults in automobile circuit/ wiring harness. | 2 | CO1 |
| LLO 3.1 Perform battery specific gravity test.<br>LLO 3.2 Perform battery terminal test. | 3 | *Battery specific gravity test and battery terminal test. | 2 | CO2 |
| LLO 4.1 Perform battery load test.<br>LLO 4.2 Perform battery drain test. | 4 | Battery load test and battery drain test. | 2 | CO2 |
| LLO 5.1 Inspect the battery visually.<br>LLO 5.2 Test the battery terminals and clamps.<br>LLO 5.3 Test the battery voltage.<br>LLO 5.4 Perform battery charging. | 5 | *Regular maintenance of battery. | 2 | CO2 |
| LLO 6.1 Dismantle the given alternator.<br>LLO 6.2 Examine the internal components of alternator.<br>LLO 6.3 Assemble the given alternator.<br>LLO 6.4 Measure alternator drive belt tension. | 6 | *Dismantle and assemble the alternator. | 2 | CO2 |
| LLO 7.1 Test the Continuity of the stator windings.<br>LLO 7.2 Test the Continuity of rotor winding.<br>LLO 7.3 Inspect the diode rectifier. | 7 | Continuity test of alternator stator and rotor windings. | 2 | CO2 |
| LLO 8.1 Perform the Current Output Test.<br>LLO 8.2 Perform the Field Current Draw Test. | 8 | Current Output Test and Field Current Draw Test on alternator. | 2 | CO2 |
| LLO 9.1 Perform the Regulator Output Test.<br>LLO 9.2 Perform the Charging Circuit Resistance Test. | 9 | *Regulator Output Test and Charging Circuit Resistance Test on alternator. | 2 | CO2 |
| LLO 10.1 Dismantle the given starter motor.<br>LLO 10.2 Identify the components of starter motor.<br>LLO 10.3 Assemble the starter motor. | 10 | *Dismantle and assemble the starter motor. | 2 | CO3 |
| LLO 11.1 Perform the Current Draw Test.<br>LLO 11.2 Perform the Insulated Circuit Resistance Test. | 11 | Current Draw Test, Insulated Circuit Resistance Test on starter motor. | 2 | CO3 |
| LLO 12.1 Perform the Ground Circuit Test.<br>LLO 12.2 Perform the No-Crank Test.<br>LLO 12.3 Perform the Free Speed Test. | 12 | *Ground Circuit Test, No Crank Test and Free Speed Test on starter motor. | 2 | CO3 |
| LLO 13.1 Interpret timing marks on the crankshaft pulley or flywheel.<br>LLO 13.2 Make use of a stroboscope for measuring ignition timing.<br>LLO 13.3 Modify ignition timing or Electronic Control Unit (ECU) settings. | 13 | Ignition timing inspection of a multi-cylinder engine with Stroboscope. | 2 | CO3 |
| LLO 14.1 Test the given transducer. | 14 | Test the sensor and fuel injector. | 2 | CO4 |

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| Practical / Tutorial / Laboratory Learning Outcome (LLO) | Sr No | Laboratory Experiment / Practical Titles / Tutorial Titles | Number of hrs. | Relevant COs |
|---|---|---|---|---|
| LLO 15.1 Make use of a diagnostic scan tool.<br>LLO 15.2 Diagnose faults in body control functions.<br>LLO 15.3 Interpret Diagnostic Trouble Codes (DTCs) related to the Body Control Unit (BCU). | 15 | *Fault diagnosis of the body control unit using a scan tool. | 2 | CO4 |

**Note : Out of above suggestive LLOs -**

- '*' Marked Practicals (LLOs) Are mandatory.
- Minimum 80% of above list of lab experiment are to be performed.
- Judicial mix of LLOs are to be performed to achieve desired outcomes.

## VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)

**Micro project**

- Not Applicable

**Assignment**

- Not Applicable

**Note :**

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicial mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- For courses with no SLA component the list of suggestive microprojects / assignments/ activities are optional, faculty may encourage students to perform these tasks for enhanced learning experiences.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

## VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

| Sr.No | Equipment Name with Broad Specifications | Relevant LLO Number |
|---|---|---|
| 1 | Wiring harness of two and four wheeled vehicle. | 1,2 |
| 2 | Digital Multimeter: LCD Display, 0 to 50ºC Operating Temperature, DCvoltage-200mV to 1000 V DC, 2 to 1000 V Alternating Current, Current:2mA to 20 A DC, Diode Test, Continuity Test- Audible buzzer, Resistance: 200 ohm to 200 mega ohm; Accessories: Test leads, Current Clamp 300 A, Current Clamp Adapter. | 1,2,3,4,5,6,7,8,9,11,12,14 |
| 3 | Trainer electrical circuits of two and four wheeled vehicle. | 1,2,3,9,11,12 |
| 4 | Starter Motor – 12V, 0.7KW. Over running clutch type. | 10,11,12 |
| 5 | Stroboscope/ Timing gun: Ignition Advance: 0 to 45º, 12V DC system, Reverse polarity protection, Bright flash for daylight use. | 13 |
| 6 | Multiport Fuel Injection engine with sensors, actuators and Electronic Control Module, Exhaust Gas Regulation valve and Positive Crankcase Ventilation valve; Power: 25 KW @ 5000 rpm to 55KW@ 5000 rpm, Cubic Capacity: 800 CC to 2000 CC. | 13,14,15 |

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| Sr.No | Equipment Name with Broad Specifications | Relevant LLO Number |
|---|---|---|
| 7 | Scan tool: On Board Diagnostics (OBD) II Generation Scan Tool, Controller area network enabled, Colour Display, Operating Temperature: 0 to 50ºC, Internal Storage: 4 AAA batteries, External Power: 7 to 18 volts; Generic tool; Accessories: Extender cable, OBD II Cable; Relevant optional accessories. | 15 |
| 8 | Battery – 12V,100Amp or above. | 3,4,5,9,11,12 |
| 9 | Hydrometer bulb type or digital 1.100-1.300 Sp. gravity at 27 degree Celsius. | 3,5 |
| 10 | Battery Charger. 2A-10A, 12V-24V | 5 |
| 11 | Alternator – 12V, 40A | 6,7,8,9 |
| 12 | Direct Current Clamp meter: Current measurement – 400 Amperes DC / AC. | 8,11,12 |
| 13 | Auto electrical Test bench –3 phase, 5 HP | 8,9,11,12 |
| 14 | Hand tools: spanner set: Open ended spanner set, Ring spanner set, Box spanner set;<br>Screw driver set, Pliers: Nose plier, Circlip plier, Grip plier ;<br>Engine Belt Tension Gauge, Allen key set, wire brush: internal and external brushes for battery terminal and battery clamp. | All |

## IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

| Sr.No | Unit | Unit Title | Aligned COs | Learning Hours | R-Level | U-Level | A-Level | Total Marks |
|---|---|---|---|---|---|---|---|---|
| 1 | I | Electrical Components, Circuit Protection Devices, and Smart Wiring Systems | CO1 | 8 | 0 | 0 | 0 | 0 |
| 2 | II | Automotive Batteries and Charging System | CO2 | 8 | 0 | 0 | 0 | 0 |
| 3 | III | Cranking and Ignition System | CO3 | 8 | 0 | 0 | 0 | 0 |
| 4 | IV | Automotive Transducers and On Board Diagnostics (OBD) -II System | CO4 | 6 | 0 | 0 | 0 | 0 |
| **Grand Total** | | | | **30** | **0** | **0** | **0** | **0** |

## X. ASSESSMENT METHODOLOGIES/TOOLS

**Formative assessment (Assessment for Learning)**

- For laboratory learning, 25 marks. For FA PR ,Formative (Continuous ) assessment shall be based on process and product related performance indicators. Course teacher may assign 60%, weightage for process and 40% weightage for product related LL work .

**Summative Assessment (Assessment of Learning)**

- For SA PR At the end of semester PR examination will be conducted by course teacher and based on PR exam performance marks out of 50 will be allocated.

## XI. SUGGESTED COS - POS MATRIX FORM

| Course Outcomes (COs) | Programme Outcomes (POs) | | | | | | | Programme Specific Outcomes* (PSOs) | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | PO-1 Basic and Discipline Specific Knowledge | PO-2 Problem Analysis | PO-3 Design/ Development of Solutions | PO-4 Engineering Tools | PO-5 Engineering Practices for Society, Sustainability and Environment | PO-6 Project Management | PO-7 Life Long Learning | PSO-1 | PSO-2 | PSO-3 |
| CO1 | 3 | 1 | - | 3 | - | - | 3 | | | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| CO2 | 3 | 1 | - | 3 | - | - | 3 | | | |
| CO3 | 3 | 1 | - | 2 | - | - | 3 | | | |
| CO4 | 3 | 1 | - | 3 | - | - | 3 | | | |

Legends :- High:03, Medium:02,Low:01, No Mapping: -
*PSOs are to be formulated at institute level

## XII. SUGGESTED LEARNING MATERIALS / BOOKS

| Sr.No | Author | Title | Publisher with ISBN Number |
|---|---|---|---|
| 1 | James D. Halderman | Automotive Electricity and Electronics | 5th Edition Year: 2016, PEARSON ISBN-13: 978-0-13-576442-8 |
| 2 | James D. Halderman | Diagnosis and Troubleshooting of Automotive Electrical, Electronic, and Computer Systems | 5th Edition, Year: 2009, Pearson College Div., ISBN-13: 978-0135066966 |
| 3 | Tom Denton | Automobile Electrical and Electronic Systems | 5th Edition, Routledge, ISBN-13: 978-0415725774 |
| 4 | A.K. Babu | Automotive Electrical and Electronics | 2nd Edition, Year: 2024, Khanna Publishing House ISBN 13 978-93-82609-69-8 |
| 5 | Dr. P. Thangavel, Dr. M. Vijay Anand, Mr. M. Makeshkumar | Automotive Electrical & Electronics Concepts | Year: 2025, Notion Press, ISBN-13: 979-8896991731 |

## XIII . LEARNING WEBSITES & PORTALS

| Sr.No | Link / Portal | Description |
|---|---|---|
| 1 | https://www.youtube.com/watch?v=mEJEHxlbn9o | How to Use Wiring Diagrams for Car Electrical Diagnosis and Repair |
| 2 | https://www.youtube.com/watch?v=0ihkfUbddsk | Circuit Breakers and Fuses Explanation |
| 3 | https://www.youtube.com/watch?v=wWGyUpUsZkU | What is Can bus cable, construction, application Automotive ECU to MCU wiring connection |
| 4 | https://www.youtube.com/watch?v=hObLxlXJPPM | Working Principle of Lead Acid Battery |
| 5 | https://www.youtube.com/watch?v=nrxmQhbZUTc&t=780s | The Battery Basics: Understanding Lithium-Ion, Lead-Acid Battery |
| 6 | https://www.youtube.com/watch?v=cxkVxi9P0EA | Battery Rating |
| 7 | https://www.youtube.com/watch?v=v4JGYu4aaEc | Causes and Types of Battery Failure |
| 8 | https://www.youtube.com/watch?v=V7EFAvFPOhw&t=25s | Battery Maintenance |
| 9 | https://www.youtube.com/watch?v=Gc1hWC3XQI0 | Hydrometer Test of Lead Acid Battery |
| 10 | https://www.youtube.com/watch?v=YrNRaPP7EKU | Battery Terminal Test |
| 11 | https://www.youtube.com/watch?v=jdSKlg80DjU | Alternator Working Principle |
| 12 | https://www.youtube.com/watch?v=EVPoI5wgZ4o | Alternator Testing |
| 13 | https://www.youtube.com/watch?v=lNUikOnGlAE | PCM (Computer) Controlled Alternators |
| 14 | https://www.youtube.com/watch?v=1bK0De9XOP0 | Alternator Testing |
| 15 | https://www.youtube.com/watch?v=9UKg71wa0e4 | Alternator Belt Tension |

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| Sr.No | Link / Portal | Description |
|---|---|---|
| 16 | https://www.youtube.com/watch?v=Lfvig36a3og&t=20s | SHVS mild hybrid + DUALJET |
| 17 | https://www.youtube.com/watch?v=arWoIjk6seA&t=17s | How electrical and ignition systems work |
| 18 | https://www.youtube.com/watch?v=4dPXUzYiGmQ | Camshaft Position Sensor Explained with Animation |
| 19 | https://www.youtube.com/watch?v=CpmOv83HYhQ | Throttle Position Sensor Explained with Animation |
| 20 | https://www.youtube.com/watch?v=OhShoU_E-0g&t=394s | OBD2 Explained - A Simple Intro |
| 21 | https://www.youtube.com/watch?v=YGG9VLzeMk8&t=11s | How to Use an OBD2 Scan Tool |

**Note :**

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students

**MSBTE Approval Dt. 04/09/2025** **Semester - 6, K Scheme**