

GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)**Competency-focused Outcome-based Green Curriculum-2021 (COGC-2021)
Semester -III**

Course Title: **Automobile Electrical and Electronic System**
(Course Code: 4330203)

Diploma programme in which this course is offered	Semester in which offered
Automobile Engineering	3rd

1. RATIONALE

Most components of earlier generation vehicles were mainly mechanical in nature and operation. Over time components started operating electrically/electronically and microprocessor-based systems. Nowadays utmost automotive components and new accessories have an electric function for ease of operation and precision control. Hence the fundamental knowledge of automotive battery, ignition system, starting & charging system and electronics are most essential. This course is helpful to learners to understand fundamental knowledge of electrical and electronic basic working principles & applications. This course is pre-requisite for maintenance and service-III.

2. COMPETENCY

The course content should be taught and curriculum should be implemented with the aim of developing different types of skills leading to the achievement of the following competencies.

- **Apply the knowledge of construction and working of various automotive electrical & electronics system and components.**

3. COURSE OUTCOMES (COs)

The underpinning knowledge and the relevant skills associated with this competency are to be developed in the student to display the following COs:

- Explain basic electrical principles, construction and working of various electrical auxiliaries systems.
- Interpret the purpose, construction and working of various types of automotive battery.
- Explain construction and working of various automotive ignition system.
- Interpret necessity, construction & operation of various types of starter motor and charging system's components.
- Explain basic working principles & applications of electronics in automotive systems.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				
L	T	P		Theory Marks		Practical Marks		Total Marks
			C	CA	ESE	CA	ESE	
3	0	2	4	30*	70	25	25	150

(*): Out of 30 marks under the theory CA, 10 marks are for assessment of the micro-project to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessing the attainment of the cognitive domain UOs required for the attainment of the COs.

Legends: **L**-Lecture; **T** – Tutorial/Teacher Guided Theory Practice; **P** - Practical; **C** – Credit, **CA** - Continuous Assessment; **ESE** - End Semester Examination.

5. SUGGESTED PRACTICAL EXERCISES

The following practical outcomes (PrOs) that are the sub-components of the COs. *These PrOs need to be attained to achieve the COs.*

S. No	Practical Outcomes (PrOs)		Unit No.	Approx. Hrs. required
1	Identify various fuse ratings as per given specification.	Any two	I	04
2	Draw and explain any one automotive wiring diagram of given vehicle electric & electronic system.		I	04
3	Interpret any one circuit diagram of wiring system among given auxiliary system & accessories.		I	04
4	Identify and perform joining procedure of automotive wiring circuit with its cable size, color code and symbols used in a given vehicle electric & electronic system.		I	04
5	Perform battery state-of-charge test in different real-time vehicle load conditions.	Any one	II	04
6	Prepare SOP (standard operating procedure) and perform visual inspection procedure for identify various battery rate and conditions.		II	04
7	Experiment related to identify, inspection of modern ignition system or prepare line diagram related to ignition system for demonstration purpose.	Any one	III	04
8	Differentiate various spark plugs by constructional features & rating.		III	04
9	Dismantle/Assemble the given starter motor, enlist the parts, and explain the working of each component.	Any one	IV	04
10	Dismantle/Assemble the given alternator, enlist the parts and explain the working of each component.		IV	04
11	Carry out input and output methodology of various sensors using sensor test kit.	Any two	V	04
12	Identify, locate and functional details various sensors from engine, transmission, and electrical system in a particular vehicle.		V	04
13	Read and interpret the name plate (specifications plate) details of the stepper motor & identify the parts of the stepper motor from the real object.		V	04
	Total Hrs.			28

Note

- i. More **Practical Exercises** can be designed and offered by the respective course teacher to develop the industry relevant skills/outcomes to match the COs. The above table is only a suggestive list.
- ii. Care must be taken in assigning and assessing study report as it is a first-year study report. Study report, data collection and analysis report must be assigned in a group. Teacher must discuss about type of data (which and why) before group starts their market survey.
- iii. The following are some **sample** 'Process' and 'Product' related skills (more may be added/deleted depending on the course) that occur in the above listed **Practical Exercises** of this course required which are embedded in the COs and ultimately the competency.

S. No.	Sample Performance Indicators for the PrOs	Weightage in %
1	Identify electrical system component, its location in vehicle and describe its function and working.	40
2	Prepare neat sketch, layout with name of component.	20
3	Answer to question	20
4	Timely completion of tasks	20
Total		100

6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

These major equipment with broad specifications for the PrOs is a guide to procure them by the administrators to usher in uniformity of practical in all institutions across the state.

S. No.	Equipment Name with Broad Specifications	PrO. No.
1	Multimeter - (AC Voltage Range: 600mV-1000V, DC Voltage Range: 600mV-1000, AC Current Range: 660 μ A-10A, DC Current Range: (Amp) 660 μ A-10A, Resistance Range: (Ohm) 600 Ω -66M Ω , Capacitance Range: (F) 6.6nF-66mF, Frequency Range: (Hz) 66Hz-66MHz)	01 to 13
2	AC to DC converter (0-30V) and (0-30A)	01 to 13
3	Executive Auto Electrical tool kit	01 to 13
4	Typical wiring of a vehicle (Including all lighting systems, all gauges, wiper motor, starter motor, alternator, ignition system with proper power supply)	02
5	Dual Heat Professional Soldering Gun (260/200 watt) with Clear Silicone Paste and Rosin Paste Flux.	03,04
6	Adjustable Helping Hand with Magnifying Glass, Soldering Station Stand with Dual Alligator Clips and a Heavy Base	03,04
7	Wire stripper from (10-24 AWG)	03,04
8	Heat Shrink Tubing Tube Sleeving Wrap Cable Wire with different Color and Size.	03,04
9	Heat Gun with 2 Temp Settings 750°F & 1000°F	03,04

10	Hand operated crimping tool (i) for crimping up to 4mm and (ii) for crimping up to 10mm	03,04
11	Portable Battery Tester with Consist of Dc Voltmeter, Load Resistor and Testing Clip (Rated Voltage of Battery to Be Tested: 2, 6, 12V DC, Rated Capacity of Battery to Be Tested: 4 - 500ah)	05,06
12	Digital ignition timing gun (stroboscope) with LED display (Accurate to 8,000rpm, 12V)	07
13	Clamp Multimeter (DC current 60A/600A)	07
14	Various features of Spark plug having nickel chromium finishing	08
15	Any one Starter motor for disassemble.	09
16	Any one Alternator for disassemble	10
17	Sensor working kit Sensor working kit (petrol engine, including fuel injector pulse and spark plug firing, and with sensor likes ECT, IAT, Light, TP, Distance, oxygen, MAP, vehicle speed)	11,12
18	Any one stepper motor	13

7. AFFECTIVE DOMAIN OUTCOMES

The following *sample* Affective Domain Outcomes (ADOs) are embedded in many of the above-mentioned COs. More could be added to fulfil the development of this course competency.

- a) Work as a leader/a team member.
- b) Follow ethical practices.
- c) Practice environmentally friendly methods and processes. (Environment related)

The ADOs are best developed through the field-based exercises/project work. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

- i. 'Valuing Level' in 1st year
- ii. 'Organization Level' in 2nd year.
- iii. 'Characterization Level' in 3rd year.

8. UNDERPINNING THEORY

The major underpinning theory is given below based on the higher level UOs of *Revised Bloom's taxonomy* that are formulated for development of the COs and competency. If required, more such higher level UOs could be included by the course teacher to focus on attainment of COs and competency.

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
Unit I Basic of Electricity and Auxiliaries system.	1.a State importance and significance of basic electrical principles. 1.b Explain basic concept of automotive wiring. 1.c Explain construction and working of various electrical and auxiliaries system. 1.d Explain construction and working of analog and digital gauges. 1.e Describe fundamentals of automotive lightning system.	1.1 Basic electrical principles -Effects of current flow, and definition of electrical quantities like resistance, voltage, current, and power. -Differences between Conductors, insulators and semiconductors, -Basics of Magnetism, electromagnetism, Electromagnetic induction, Mutual induction. - Differences between electron flow and conventional flow. 1.2 Fundamentals of automotive wiring, terminals, cables, color codes, harness design, fuses, relay and circuit breakers, and switches. 1.3 Construction and working of various electrical auxiliaries systems – -Windscreen washers and wipers, - Signaling circuits, - Horns, - Engine cooling fan motors, - electric window 1.4 Construction and working of analog and digital gauges such as - Tachometers, - Odometers, - Speedometers, - Oil pressure gauges, - Coolant temperature gauge, - Fuel level gauge. 1.5 Automotive Lighting fundamentals, - Bulbs, - Headlight reflectors, - Headlight lenses, - Basic lighting circuit,

		<ul style="list-style-type: none"> - Gas discharge lamps and - LED lighting.
Unit II Automotive battery	<p>2.a Explain construction and working of automotive batteries.</p> <p>2.b Explain battery disposal and handling procedure.</p>	<p>2.1 Vehicle batteries Various types of battery, Requirements of the vehicle battery, Choosing the correct battery, parameters affecting battery performance.</p> <p>2.2 Lead-acid batteries Construction, working, chemical reaction during charging and discharging, Battery rating and efficiency,</p> <p>2.3 Lithium-ion batteries Construction, working, comparison between lead acid batteries and lithium-ion batteries.</p> <p>2.4 lead-acid battery Waste, battery disposal, battery handling and storage.</p>
Unit III Ignition system	<p>3.a Explain construction and working of various Ignition system.</p> <p>3.b Describe various types of spark plug and rating.</p>	<p>3.1 Necessity and requirement of Ignition system in automobile vehicles.</p> <p>3.2 Construction and working of breaker point ignition system, electronic ignition system and distributor less ignition system.</p> <p>3.3 Construction, working and types of Spark plugs.</p> <p>3.4 Working of Non-Contact-type Ignition Triggering devices.</p> <p>3.5 Construction and working of Capacitive Discharge Ignition.</p>
Unit IV Starting and charging system	<p>4.a Explain construction and working of different starting system.</p> <p>4.b Describe necessity and requirement of charging system in vehicle.</p>	<p>4.1 Necessity and requirements of the starting system.</p> <p>4.2 Basic working of Starting system circuits.</p> <p>4.3 Describe D.C motor characteristics.</p> <p>4.4 Constructional and working principle of different starter motor</p> <ul style="list-style-type: none"> - Pre-engaged starters, - Permanent magnet starters, - Various drive mechanisms of starter motor. <p>4.5 Necessity and requirements of the charging system</p> <ul style="list-style-type: none"> - Basic operating principles,

		<ul style="list-style-type: none"> - Alternator characteristics, - Construction and working of Alternator, - Requirement of regulators, - Working of regulators.
Unit V Automotive Electronics	<p>5.a State importance and significance of electronics components and circuits.</p> <p>5.b Explain the concepts of ECU in automotive applications.</p> <p>5.c Understand the basic architecture of Microcontroller.</p> <p>5.d Acquire knowledge of the sensing technique and working of automotive sensors.</p> <p>5.e Interface automotive sensors and actuators with microcontrollers.</p>	<p>5.1 Electronic components and circuits introduction, components, electronics symbols, Integrated circuits, Amplifiers, Bridge circuits, Digital-to-analogue conversion, Analogue-to-digital conversion, Logic gates, Combinational logic, Timers and counters, Memory circuits, Clock, or a stable circuit</p> <p>5.2 Microprocessor systems Introduction, Ports, Central processing unit (CPU), Memory, Buses, A typical microprocessor, Microcontrollers</p> <p>5.3 Construction, working and use of various Sensors</p> <ul style="list-style-type: none"> -Thermistors, -Thermocouples, -Inductive sensors, -Hall Effect, -Strain gauges, -Various Variable capacitance sensors, -Accelerometer (knock sensors), -LVDT, RVDT, -various flow sensors, -Optical sensors, -Light sensors, -Thick-film air temperature sensor, -Methanol sensor, -Rain sensor, -Oil sensor, -Dynamic vehicle position sensors. <p>5.4 Construction, working and use of Actuators</p> <ul style="list-style-type: none"> -Solenoid actuators, -Motorized actuators, -Stepper motors, -Synchronous motors, -Thermal actuators.

Note: The UOs need to be formulated at the 'Application Level' and above of Revised Bloom's Taxonomy' to accelerate the attainment of the COs and the competency.

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Basic of Electricity and Auxiliaries system.	9	8	4	2	14
II	Automotive battery	8	6	4	4	14
III	Ignition system	8	8	4	2	14
IV	Starting and charging system	8	8	4	2	14
V	Automotive Electronics	9	6	4	4	14
	Total	42	38	19	13	70

Legends: R=Remember, U=Understand, A=Apply and above (Revised Bloom's taxonomy)

Note: This specification table provides general guidelines to assist student for their learning and to teachers to teach and question paper designers/setters to formulate test items/questions to assess the attainment of the UOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may slightly vary from above table.

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related **co-curricular** activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should conduct following activities in group and prepare reports of each activity. They should also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:

- Charts can be prepared.
- Small report on any topic given by concern faculty.
- Small groups of students can be formed for assigned work. Assigned work should be such that it covers market survey, team work, presentation, time management, quality development.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

- Massive open online courses (**MOOCs**) may be used to teach various topics/sub topics.
- Guide student(s) in undertaking micro-projects.
- 'L' in section No. 4** means different types of teaching methods that are to be employed by teachers to develop the outcomes.

- d) About **20% of the topics/sub-topics** which are simpler or descriptive in nature are to be given to the students for **self-learning**, but to be assessed using different assessment methods.
- e) With respect to **section No.10**, teachers need to ensure to create opportunities and provisions for **co-curricular activities**.
- f) **Guide students on how to address issues on environment and sustainability**

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-projects are group-based. However, in the fifth and sixth semesters, it should be preferably **individually** undertaken to build up the skill and confidence in every student to become a problem solver so that she/he contributes to the projects of the industry. In special situations where groups must be formed for micro-projects, the number of students in the group should **not exceed three**.

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based, or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The total duration of the micro-project should be about **14 - 16 (fourteen to sixteen) student engagement hours** during the course. The student ought to submit micro-project by the end of the semester to develop the industry-oriented COs.

A suggestive list of micro-projects is given here. This must match the competency and the COs. Similar micro-projects could be added by the concerned course teacher:

1.	Study and compare any two types of vehicles wiring harness color coding data.
2.	Perform automotive wiring soldering process using proper tools and equipment.
3.	Draw basic layout of fuse box of any three vehicles and compare each item with fuse - Amp detail.
4.	Prepare a report on Initiatives taken by CPCB for collection, recycling, scrap, and handling of batteries namely lead acid, nickel-cadmium, nickel metal hydride and Lithium-ion batteries
5.	Prepare an SOP of battery scrap needs to be followed by Scrap vendor during scrap of vehicle.
6.	Visit authorized battery dealer shop and prepare a report on tools equipment usage, with manufacturer techno commercial detail and safety norms followed in shop.
7.	Prepare and understand the layout of Ignition system used in vehicle with each component specification.
8.	Prepare and compare specification chart of starter motor and alternator of any five vehicles.

9.	Calculate current and resistance of starter system of any particular vehicle.
10.	Calculate current and resistance of charging system of any particular vehicle.
11.	Visit any vehicle scrap yard, authorized dealer near area and collect scrap sensor and do checking of voltage drop test and continuity test for the same.
12.	Prepare working model of any sensors.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication with place, year and ISBN
1	Automobile Electrical and Electronic Systems	Tom Denton	Routledge, 2017, 5th edition, ISBN:978-0415725774
2	Automotive Electricity and Electronics	James Halderman	Pearson, 2016, 5th edition, ISBN:978-0134073644
3	Automotive Electrical Equipment	P. L. Kohli	McGraw Hill Education, 2017, ISBN: 978-0074602164
4	Automotive Electrical and Electronics	A. K. Babu	Khanna Publishing, 2018, ISBN: 978-9382609698
5	Automobile Mechanics	William Crouse	Tata Mc-Graw Hill Publication ISBN-13:978-0-07-063435-0

14. SOFTWARE/LEARNING WEBSITES

- a) <https://www.howacarworks.com>
- b) <https://swayam.gov.in>
- c) <https://auto.howstuffworks.com>
- d) <https://nptel.ac.in>
- e) <https://tinyurl.com/3ruk3xa> for video link
- f) <https://tinyurl.com/bdck9bdz> for web link

15. PO-COMPETENCY-CO MAPPING

Semester III	Automobile electrical and electronics system(4330203)						
	POs						
Competency & Course Outcomes	PO 1 Basic & Discipline specific knowledge	PO 2 Problem Analysis	PO 3 Design/development of solutions	PO 4 Engineering Tools, Experimentation & Testing	PO 5 Engineering practices for society, sustainability & environment	PO 6 Project Management	PO 7 Life-long learning
Apply the knowledge of construction and working of various automotive electrical & electronics system and components.	3			2	2		2
a) Explain basic electrical principles, construction and working of various electrical auxiliaries systems.	3	-	-	2	-	-	2
b) Interpret the purpose, construction and working of various types of automotive battery.	3	-	-	2	2	-	2
c) Explain construction and working of various automotive ignition system.	3	-	-	2	-	-	2
d) Interpret necessity, construction & operation of various types of starter motor and charging system's components.	3	-	-	2	-	-	2
e) Explain basic working principles & applications of electronics in automotive systems.	3	-	-	2	-	-	2

Legend: '3' for high, '2' for medium, '1' for low and '-' for no correlation of each CO with PO

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE**GTU Resource Persons**

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GTU BOS and Branch Co-Ordinator Persons

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