

GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2021 (COGC-2021)

Semester -VI

Course Title: **Maintenance & Service -III**

(Course Code: 4360203)

Diploma programme in which this course is offered	Semester in which offered
Automobile Engineering	6th

1. RATIONALE

Understanding and maintaining electrical systems in automobiles is crucial for aspiring automobile engineers due to their increasing reliance on these systems for various functions. Maintenance and service of automobile electrical systems provide students with hands-on experience in diagnosing, repairing, and maintaining electrical components, enabling them to identify and rectify potential safety hazards caused by faulty electrical components. Moreover, teaching maintenance and service of automobile electrical systems ensures that students stay up to date with the latest technologies and advancements in automotive technology, such as advanced electronics, ignition system, starting and charging system and autonomous features, making them better prepared to work on modern vehicles.

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 competency.

- **Diagnose, repair, and maintain various automotive electrical and electronic systems and components, ensuring safety and functionality in modern vehicles.**

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:

- a) Examine automotive battery systems, components, and specifications with necessary safety precautions.
- b) Evaluate the ignition system based on the results of various tests conducted on ignition system components.
- c) Evaluate and analyze vehicle starting system according to test results and overhauling inspection.
- d) Evaluate and analyze vehicle charging system according to test results and overhauling inspection.
- e) Describe vehicle auxiliary and sensor's performance according to On-Board Diagnosis (OBD) fault codes and interpretation.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				
L	T	P	C	Theory Marks		Practical Marks		Total Marks
				CA	ESE	CA	ESE	
2	0	2	3	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) are the sub-components of the COs. These PrOs need to be attained to achieve the COs.

Sr. No	Practical Outcomes (PrOs)		Unit No.	Approx. Hrs. required
1	Conduct a load test using a battery load tester to evaluate the battery's performance under load.	Any two	I	4
2	Perform a jump start by connecting jumper cables between a charged battery and a discharged battery, following the correct sequence of connections and safety guidelines.			4
3	Diagnose battery drain or parasitic draw using a multimeter to identify excessive draw.			4
4	Conduct testing of the ignition system using multimeter/ohmmeter/oscilloscope to check condition of coil.	Any one	II	4
5	Perform specific tests for spark plugs to evaluate their condition.			4
6	Conduct testing of starter motor using multimeter to analyze condition and diagnose malfunction within it.	Any one	III	4
7	Overhaul and analyze Growler test of an armature.			4
8	Conduct testing of alternator-generator using multimeter to analyze condition and diagnose malfunction within it.	Any one	IV	4
9	Overhaul and analyze stator, rotor, and rectifier of an alternator.			4
10	Conduct testing of various sensors OBD fault codes and its interpretation.	Any Two	V	4
11	Perform testing of various sensor using multimeter.			4

12	Perform testing of various motorized actuator using multimeter.			4
Total Hrs.				28

Note

- i. More **Practical Exercises** can be designed and offered by the respective course teacher to develop the relevant industry skills/outcomes to match the COs. The above table is only a suggestive list.
- ii. Care must be taken in assigning and assessing study reports as it is a study report. Study reports, data collection and analysis reports must be assigned in a group. The teacher must discuss the data type (which and why) before the 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 the competency.

S. No.	Sample Performance Indicators for the Practical's	Weightage in %
1	Basic knowledge and understanding of experiments	40%
2	Identification of components of experiments	20%
3	Answer to questions	20%
4	Timely submission	20%
Total		100%

6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

This 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.

Sr. No.	Equipment Name with Broad Specifications	PrO. No.
1	Battery load tester (12 V)	01
2	10-gauge jumper cables (02 Nos.)	02
3	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)	All
4	Digital oscilloscope (8-36V Wide range of input voltage) (min. 2 channel)	04
5	Spark plug tester & cleaner (260 W)	05
6	Bearing puller	06
7	Growler armature tester	07
8	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)	10

9	<p>Scan Tool:</p> <ul style="list-style-type: none"> – Screen 8" diagonal, daylight readable color LCD screen; 1280*800 pixel – Touch with Gloves Supported – Operating System Android system – CPU Quad-Core, 1.3GHz – Memory 2GB DDR3L – SSD Hard drive 32GB – Communication Interface Built-in WIFI 802.11 b/g Wireless LAN micro USB 2.0 OTG, USB 2.0 HOST standard Bluetooth 4.0 (10-20 m) – HDMI Yes – Camera 5 megapixels rear-facing – Battery 8000mAh, lithium-polymer battery. Chargeable via 5V AC/DC power supply – Protocols ISO 9141-2, ISO 14230-2(KWP2000), SAE J1850-PWM, SAE J1850-VPW, SAE J2740(GM UART), UART Echo Byte Protocol(SAE J2809、SAE J2818), Honda Diag-H Protocol, SAE J2610(SCI), ISO 11898, ISO 15765-4, KW81, KW82, GWM 3089 (Single Wire CAN), SAE J2819(TP2.0), SAE J3054(TP1.6), ISO 11898-3(Low Speed Fault-Tolerant CAN), SAE J2284 (High Speed CAN) – OBD2 Compatible with Indian cars 	10
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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 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 Automotive Battery	1.a Implementing battery safety and performance. 1.b Evaluating battery-related problems and solutions. 1.c Apply different battery testing techniques. 1.d Understand charging methods and jump start process.	1.1 Battery Maintenance and safety precaution: - Precaution steps taken while servicing battery. - Visually inspect for damage or corrosion. - Cleaning of battery terminals and connectors. - Topping up electrolyte (for lead acid battery) 1.2 Battery diagnosis and troubleshooting: - Identifying common battery-related issues. - Symptoms of a weak or faulty battery. - Diagnosing battery drain or parasitic draw. - Different trouble causes and remedies of the battery. 1.3 Battery Testing: - Various terminology used for battery testing. - Voltage measurement using a multimeter, Load test, Hydrometer test, Cadmium test. - Testing via battery analyzer. - Interpreting battery test results. 1.4 Battery Charging and jump start: - Various charging processes and their use. - Step-by-step process of connecting jumper cables correctly and safely.
Unit II	2.a Apply safe and effective maintenance to the ignition system.	2.1 Maintenance of ignition system: - Periodic maintenance of ignition system. (Spark plugs, ignition

Automotive Ignition system	<p>2.b Applying precise troubleshooting and diagnostic techniques for ignition faults.</p> <p>2.c Analyzing, testing, and interpreting ignition system components.</p>	<p>coil, control module, wiring system, triggering devices)</p> <ul style="list-style-type: none"> - Safety precaution during Maintenance and service of ignition system. <p>2.2 Diagnosis of ignition system:</p> <ul style="list-style-type: none"> - Diagnostic Procedures for Identifying Ignition System Faults. - Troubleshooting Common Ignition System Issues and their remedies. <p>2.3 Testing of ignition systems:</p> <ul style="list-style-type: none"> - Checking and setting ignition timing. - Testing of ignition system using oscilloscope. - Testing of all components of ignition system. - Testing of spark plug. - Interpreting various test results. <p>2.4 Recycling and disposal of Ignition system.</p>
<p>Unit III</p> <p>Automotive Starting system</p>	<p>3.a Apply safe and effective maintenance to the Starting system.</p> <p>3.b Applying precise troubleshooting and diagnostic techniques for Starting system faults</p> <p>3.c Analyzing, testing, and interpreting Starting system components.</p> <p>3.d Overhauling and testing of Starting system components.</p>	<p>3.1 Maintenance of Starting system.</p> <ul style="list-style-type: none"> - Safety precaution during Maintenance and service of Starting system. <p>3.2 Diagnosis of Starting system</p> <ul style="list-style-type: none"> - Diagnostic Procedures for Identifying Starting System Faults. - Troubleshooting Procedure and starting system problem with remedies and action plan. <p>3.3 Testing of Starting system</p> <ul style="list-style-type: none"> - Visual inspection test. - Control circuit test. - Starter circuit voltage drop test. - Starter amperage test. - Starter motor field coil, growler armature and runout test. <p>3.4 Overhauling of starting system.</p>

		<ul style="list-style-type: none"> - Disassembly and assembly with precise safety of starting system components. - Proper inspection and testing of each component i.e. solenoid, drive clearance, brush inspection, bench test. <p>3.5 Recycling and disposal of starting system.</p>
Unit IV Automotive Charging system	<p>4.a Apply safe and effective maintenance to the Charging system.</p> <p>4.b Applying precise troubleshooting and diagnostic techniques for Charging system faults</p> <p>4.c Analyzing, testing, and interpreting Charging system components.</p> <p>4.d Overhauling and testing of charging system components.</p>	<p>4.1 Maintenance of Charging system</p> <ul style="list-style-type: none"> - Safety precaution during Maintenance and service of charging system. <p>4.2 Diagnosis of charging system.</p> <ul style="list-style-type: none"> - Diagnostic Procedures for Identifying Charging System Faults. - Troubleshooting Procedure and charging system problem with remedies and action plan. <p>4.3 Testing of Charging system</p> <ul style="list-style-type: none"> - Charging voltage test. - Drive belt inspection and adjustment. - AC ripple voltage & current test. - Voltage drop test. - Alternator output test <p>4.4 Overhauling of Charging system</p> <ul style="list-style-type: none"> - Disassembly and assembly with precise safety of charging system components. - Various test during overhauling i.e. testing of an alternator, rotor, stator, diode, and rectifier. <p>4.5 Recycling and disposal of Charging system.</p>
Unit V Automotive Electronics and Auxiliary System.	<p>5.a Analyzing, testing, and interpreting sensors OBD fault codes.</p> <p>5.b Applying precise troubleshooting and diagnostic techniques for various vehicle electrical Auxiliary Systems</p>	<p>5.1 Sensor characteristics and specifications.</p> <p>5.2 Evolution of On-Board Diagnosis (OBD)</p> <p>5.3 Importance of Diagnosis Trouble Codes (DTCs) in Vehicle Diagnostics.</p>

		<ul style="list-style-type: none"> - Detailed information of various sensors OBD fault codes and its interpretation. - Engine related fault codes - Transmission system related fault codes. - Emission related fault codes - Passive restraint system related fault codes. <p>5.4 Diagnosis and troubleshooting of various vehicle electrical Auxiliary Systems.</p> <ul style="list-style-type: none"> - Windscreen washers and wipers, Signaling circuits, Horns, Engine cooling fan motors, electric window, lighting circuit <p>5.5 Recycling and disposal of Auxiliary system and electronics of automobile vehicle.</p>
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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	Automotive Battery	6	3	4	7	14
II	Automotive ignition system	6	3	4	7	14
III	Automotive Starting system	5	3	4	7	14
IV	Automotive Charging system	5	3	4	7	14
V	Automotive Electronics and Auxiliary System.	6	3	4	7	14
	Total	28	15	20	35	70

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

Note: This specification table provides general guidelines to assist students 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 the 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 evidence for their (student's) portfolio which will be useful for their placement interviews:

- a) Charts can be prepared.
- b) Small report on any topic given by concerned faculty.
- c) Small groups of students can be formed for assigned work. The assigned work should be such that it covers market survey, teamwork, 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:

- a) Massive open online courses (**MOOCs**) may be used to teach various topics/subtopics.
- b) Guide student(s) in undertaking micro-projects.
- c) **'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) Regarding section No.10, teachers must ensure that 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 at 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 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 a dated work diary consisting of individual contributions to the project work and give a seminar presentation of it before submission. The total duration of the microproject 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 suggested 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) Create a DIY battery cleaning solution using household ingredients.
2) Design a low-cost battery terminal cleaning tool using everyday materials.
3) Generate a report comparing battery testing results obtained via a battery analyzer.
4) Develop a DIY ignition system cleaning kit using affordable materials such as brushes, cleaning agents, and protective coatings.
5) Create a troubleshooting report listing common ignition system issues, their symptoms, and the corresponding remedies.
6) Create a low-cost spark plug testing tool using a simple circuit to check for proper spark and firing.
7) Prepare head light tester from used headlight filament and reflector.
8) Prepare chart of specification about common sensor usage in different manufacturer vehicle.
9) Prepare a digital troubleshooting presentation listing common starting system issues with its real animated diagnosis recommendation and remedies.
10) Prepare a digital troubleshooting presentation listing common Charging system issues with its real animated diagnosis recommendation and remedies.

13. SUGGESTED LEARNING RESOURCES

Sr. No.	Title of Book	Author	Publication with place, year and ISBN
1	Automotive Mechanics (10 th edition)	William Crouse, Donald Anglin	McGraw Hill Education Publication ISBN-10: 0070634351 ISBN-13: 978-0070634350
2	Automotive Electricity and Electronics (5 th edition)	James Halderman	Pearson Publication ISBN-10: 0134073649 ISBN-13: 978-013407364
3	Automotive Electrical and Engine Performance (8 th edition)	James Halderman	Pearson Publication ISBN-10: 0135224802 ISBN-13: 978-0135224809
4	Automobile electrical and electronic systems (5 th edition)	Tom denton	Routledge Publication ISBN-10: 0415725771 ISBN-13: 978-0415725774

5	Automotive Wiring and Electrical Systems	Tony Candela	Cartech Ins Publication ISBN-10: 1932494871 ISBN-13: 978-1932494877
6	Automotive electrical equipment	P L Kohli	McGraw Hill Education Publication ISBN-13: 978-0074602164
7	Automotive Electrical and Electronics (2 nd edition)	A K Babu	Khanna Book Publishing ISBN-10: 9382609695 ISBN-13: 978-9382609698

14. SOFTWARE/LEARNING WEBSITES

- <https://www.howacarworks.com>
- <https://swayam.gov.in>
- <https://auto.howstuffworks.com>
- <https://nptel.ac.in>
- <https://tinyurl.com/4yu3vmuh> for video link
- <https://tinyurl.com/22s8cv4s> web link

15. PO-COMPETENCY-CO MAPPING

Semester VI	Maintenance & Service -III (4360203)						
	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
To effectively diagnose, repair, and maintain various automotive electrical and electronic systems and components, ensuring safety and functionality in modern vehicles.	3	3	-	3	2	-	3
a) Examine automotive battery systems, components, and specifications with necessary safety precautions.	3	2	-	2	2	-	3
b) Evaluate the ignition system based on the results of various tests conducted	3	3	-	2	2	-	3

on ignition system components.							
c) Evaluate and analyze vehicle starting system according to test results and overhauling inspection.	3	3	-	2	2	2	3
d) Evaluate and analyze vehicle charging system according to test results and overhauling inspection.	3	3	-	2	2	2	3
e) Describe vehicle auxiliary and sensor's performance according to On-Board Diagnosis (OBD) fault codes and interpretation.	3	3	2	2	2	2	3

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**

S. No	Name and Designation	Institute	Contact No.	Email
1	Mr. D. A. Dave (Retd. HOD Automobile)	Sir B.P.T.I, Bhavnagar	9427182407	deven_a_dave@yahoo.co.in
2	Mr. D. J. Gohel Lect. Automobile	C. U. Shah Polytechnic Surendranagar	9879428562	djgohel80@gmail.com
3	Mr. T. P. Gandhi Lect. Automobile	Sir B.P.T.I, Bhavnagar	9924739114	tpgautodept@gmail.com
4	Mr. M. M. Thanki Lect. Automobile	C. U. Shah Polytechnic Surendranagar	8000311010	mehul.thanki31@gmail.com
5	Mr. N. C. Makwana Lect. Automobile	Sir B.P.T.I, Bhavnagar	9725329096	ncmautodept@gmail.com

GTU BOS and Branch Co-Ordinator Persons

Sr. No	Name and Designation	Institute	Contact No.	Email
1	Mr. Shyam Varghese HOD Automobile Branch Co-Ordinator	Sir B.P.T.I, Bhavnagar	9426396640	shyamvarghese@gmail.com
2	Mr. A. K. Nanavati, HOD Automobile	Govt. Polytechnic, Ahmedabad	9426674409	aknanavati@gmail.com