GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2021 (COGC-2021)
Semester -VI
Course Title: **Maintenance & Service -I**
(Course Code: 4360201)

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

1. RATIONALE

The automotive industry heavily relies on skilled professionals who can effectively maintain and service automobile engines. There is a high demand for technicians who possess the necessary knowledge and practical skills to diagnose, troubleshoot, and repair engine-related issues. Engine malfunctions or failures can lead to hazardous situations, accidents, or breakdowns on the road. By emphasizing maintenance and service, students learn how to identify and rectify problems in automobile engines components, fuel supply system & cooling and lubricating system.

2. COMPETENCY

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

- **Apply principles, techniques, and practices involved in maintaining and servicing automobile engines**.

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) Identify diagnostic tools and techniques used in engine condition diagnosis.
b) Inspect and service/repair of engine components for signs of wear, damage, or malfunction.
c) Identify the root cause of fuel supply system issues accurately.
d) Inspect and service/repair of engine cooling system and lubricating system effectively.
e) Rebuild and overhaul engines for optimal performance and reliability.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	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) that 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 engine smoke analysis, visual inspections, and noise diagnostics to ascertain the condition of the engine.	Any one	1	4
2	Conduct engine compression and vacuum testing.		1	4
3	Perform replacement procedure of engine piston, connecting rod, crankshaft and main journal bearings.	Any one	2	4
4	Conduct an inspection and reconditioning of valves and valve seats.		2	4
5	Perform service and testing of fuel injector.	Any one	3	2
6	Trouble shooting and service procedure of fuel supply system of Petrol engine/Diesel engine.		3	4
7	Describe replacement procedure of components of cooling system.	Any Three	4	4
8	Trouble shooting and service procedure of cooling system.			
9	Perform oil changing procedure in a given vehicle.		4	4
10	Describe replacement procedure of components of lubricating system.		4	4
11	Trouble shooting and service procedure of lubricating system.		4	4
12	Perform engine tune up.	Any one	5	4
13	Perform diagnosis of engine by scan tool.		5	4
	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 study report. Study report, data collection and analysis report must be assigned in a group. Teacher has to discuss about type of data (which and why) before group start 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 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

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.

Sr. No.	Equipment Name with Broad Specifications	PrO. No.
1	Light motor vehicle: A modern car or jeep of any make and model along with all relevant accessories and systems	All
2	Digital Compression Test Kit. – Max. pressure: 300 psi (20.5 bar) (2,070 kPa) – Digital compression tester comprising of test gauge with rubber boot, 10 in. (250 mm) high-pressure hose and female quick-change coupler – 14 mm standard reach thread x 6.5 in. (165 mm) hose adapter. – 14 mm standard reach thread x 12 in. (305 mm) hose adapter – 14 mm reach thread x 12 in. (305 mm) hose adapter – 18 mm standard reach thread x 12 in. (305 mm) hose adapter – 18 mm reach male thread x 14 mm standard reach female thread plug adapter – 16 mm male thread x 14 mm standard reach female thread plug adapter – 10 mm male thread x 14 mm standard reach female thread plug adapter – 12 mm male thread x 14 mm standard reach female thread plug adapter – Air hold adapter	2
3	Digital Diesel Compression Test Kit – Max. pressure: 1000 psi (6890 kPa) (68.9 bar) – Digital compression tester comprising of test gauge with rubber boot, 15 in. (380 mm) long, high-pressure hose, quick-change coupler – Injector adapter – Glow plug adapter – Right-angle adapter – Field service kit – Displays values in psi, bar and kPa	2

4	Air Compressor: – Horse Power : 7.5 HP – Compressor Technology : Reciprocating Compressor – Model Name/Number : TS07 – Discharge Pressure : 30 BAR – Maximum Flow Rate : 11.51 CFM – Weight : 248 Kg – Product Dimension : 1490 x 600 x 695 mm	All
5	Fuel Injector Tester – Voltage 220 V – Frequency 50 Hz – Phase Phase Single Phase – Rotation Speed 10000 RPM – Tube Volume 120ml – Tank Volume 4 Liter – Fuel Flow 4.5L/min – Automation Type Automatic – Display Digital – Injection Time 0-600 sec – Oil Pump Pressure 0-6.5kg/cmA	5
6	Ultrasonic Cleaner: – Capacity (L): 2 LtrUltrasonic – Frequency: 40 Khz – Digital Timer: 5-60 minutes – Heating: 0-80°C – Power: 50 W – BasketDimension (mm): 175x165x250 mm	5
7	Scan Tool: – 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),	5, 12, 13

	SAE J3054(TP1.6), ISO 11898-3(Low Speed Fault-Tolerant CAN), SAE J2284 (High Speed CAN) – OBD2 Compatible with Indian cars	
8	Digital Multimeter – -DC 48 V Capacity – With Continuity and Resistance measurement functions	6
9	Radiator pressure tester kit – Allows Radiator Cap Relief Pressure and Seal Condition to Be Tested – Shaft Diameter: 0.47 inch – Maximum Pressure: 30 PSI – Used For: Most Vehicle Radiators – Vehicle Make: Universal	8

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 Engine condition diagnosis	1.a Students will acquire the ability to evaluate engine smoke, conduct visual inspections, and analyze engine noise to pinpoint potential issues and assess the overall condition of the engine. 1.b Students will be able to describe and conduct	1.1 Primary assessment of engine condition involves employing the following techniques: • Evaluating engine smoke to determine potential issues. • Conducting a visual inspection to identify potential sources of engine oil and coolant leakage. • Analyzing engine noise to diagnose possible problems. 1.2 Various engine test methods mentioned below:

	engine test methods, comprehend the objectives of each test, and recognize their importance in diagnosing specific engine issues.	• Engine compression test • Cylinder leakage test • Vacuum test • Oil pressure testing • Cylinder Power Balance Test
Unit II Engine components maintenance	2.a Students will have the ability to conduct in-depth inspections of the engine components, pinpointing common problems and understanding their fundamental causes. 2.b Students will be able to clarify the core principles and procedures related to these engine reconditioning techniques, with an emphasis on highlighting safety measures and precise implementation.	2.1 Service procedure, inspection, causes and remedies of following engine components: • Piston and piston ring • Connecting rod, piston pin and half -split bearings • Crankshaft and main bearing journal • Flywheel • Inlet and exhaust valve • Inlet- exhaust valve and spring assembly • Camshafts, Lifters, Timing Belts, and Chains • Combustion chamber • Engine head • Engine cylinder liners • Engine cylinder block 2.2 Describe engine repowering and reconditioning method as mentioned in the following. • Engine cylinder boring & honing. • Engine cylinder head resurfacing. • Engine valve face and seat grinding.
Unit III Maintenance and servicing of Fuel supply system	3.a Students will be able to accurately identify and classify various automotive fuel systems, including Petrol, Diesel, CNG, LPG, PFI, and GDI. 3.b Students will be able to identify problems, causes, and implement proper servicing and replacement techniques.	3.1 Common problems related to fuel supply system and its remedies (Petrol/diesel/CNG/LPG/PFI/GDI). 3.2 Inspection, problems, causes and its remedies & repair/replacement of following components of fuel supply system. • Fuel tank • Fuel line and fittings • Fuel filters • Fuel pumps

		• Fuel Injectors • Intake manifold 3.3 Servicing and replacement procedure of air filter. 3.4 Testing methods and techniques of fuel injectors. (Petrol & Diesel fuel) 3.5 Calibration and phasing of fuel injection pump
Unit IV Maintenance and servicing of engine Cooling & Lubricating system	4.a Students will be able to diagnose common cooling system problems and identify their causes. 4.b Students will be able to diagnose common lubricating system problems, such as low oil pressure, oil leaks, and oil contamination, Recommend appropriate remedies for common lubricating system problems.	4.1 Low temperature & high temperature engine problems and its remedies 4.2 Inspection and testing of coolant. 4.3 Inspection/service/Testing and repair/replacement of following components of engine cooling system. • Water pump • Thermostat valve • Hoses and gasket • Radiator & pressure cap • Cooling fan 4.4 Engine radiator flushing and cleaning technique. 4.5 Common problems related to engine lubrication system and its remedies. 4.6 Inspection, problems, causes and remedies of lubricating system and its components. 4.7 Factors affecting the oil pressure 4.8 Service and repair/replacement of Engine Oil Pump. 4.9 Procedure for changing engine oil.
Unit V Engine rebuilding and Overhauling	5.a Students will be able to formulate informed decisions on the need for engine rebuilding based on inspection findings, considering factors such as component condition, wear patterns, and overall engine health. 5.b Students will be able to conduct engine tune-ups, including adjustments to ignition timing, fuel delivery, and other parameters, to optimize engine efficiency and performance.	5.1 Reason for engine failure and need for rebuilding. 5.2 Dismantling of engine components and cleaning, visual and dimensional inspection. 5.3 Engine removal procedure. 5.4 Overhauling of engine with safety precautions. 5.5 Procedure of Engine decarbonizing. 5.6 Procedure of Engine major and minor tune up. 5.7 Diagnostic equipment scans tools.

***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	**Engine condition diagnosis**	04	3	3	6	12
II	**Engine components maintenance**	06	3	3	6	14
III	**Maintenance and servicing of Fuel supply system**	06	4	4	8	14
IV	**Maintenance and servicing of engine Cooling & Lubricating system**	08	4	6	8	18
V	**Engine rebuilding and Overhauling**	04	3	3	6	12
	Total	28	17	19	34	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:

a) Charts can be prepared.
b) Small report on any topic given by concern faculty.
c) 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:

a) Massive open online courses (***MOOCs***) may be used to teach various topics/sub topics.
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 relatively simpler or descriptive in nature is 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-project are group-based. However, in the fifth and sixth semesters, it should be preferably being ***individually*** undertaken to build up the skill and confidence in every student to become problem solver so that she/he contributes to the projects of the industry. In special situations where groups have to 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 has to match the competency and the COs. Similar micro-projects could be added by the concerned course teacher:

1) Prepare a checklist for primary assessment of engine condition.
2) Develop a training module on how to identify and diagnose engine problems based on smoke color and opacity.
3) Conduct a study on the effectiveness of different engine oil and coolant leak detection methods.
4) Develop a training module on how to perform an engine compression test, cylinder leakage test, vacuum test, oil pressure test.
5) Conduct a study on the common causes of piston and piston ring failure.
6) Develop a training module on how to service and inspect connecting rods, piston pins, and half-split bearings.
7) Conduct a study on the common causes of crankshaft and main bearing journal failure.
8) Develop a training module on how to service and inspect inlet and exhaust valve spring assemblies.

9) Conduct a study on the common causes of camshaft, lifter, timing belt, and chain failure.
10) Conduct a study on the common causes of engine head gasket failure and cracking.
11) Conduct a study on the common causes of combustion chamber carbon buildup and detonation.

13. SUGGESTED LEARNING RESOURCES

Sr. No.	Title of Book	Author	Publication with place, year and ISBN
1	Automobile Mechanics	William Crouse	Tata Mc-Graw Hill Publication ISBN-13:978-0-07-063435-0
2	Automotive Technology	James Halderman	Pearson Publication ISBN-10: 0-13-254261-7 ISBN-13: 978-0-13-254261-6
3	Advanced Automotive fault diagnosis	Tom Denton	Elsevier publication ISBN 13:978-0-75-066991-7
4	Automotive Service: Inspection, Maintenance, Repair.	Tim Gills	Cengage Learning, 2015. ISBN 13: 9781305445932
5	Vehicle Maintenance and Garage practice	Jigar A. Doshi Dhruv U. Panchal Jayesh P. Maniar	Prentice Hall India Learning Private Limited ISBN-10 : 8120349822 ISBN-13 : 978-8120349827
6	Automotive maintenance and trouble shooting.	Ernest A. Venk, Edward Dale Spicer & Irving Augustus Frazee	American Technical Society ASIN : B000U7AB7A

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/yc88v5jf for video link
f) https://tinyurl.com/5d3cjzy7 for web link

15. PO-COMPETENCY-CO MAPPING

Semester VI	Maintenance & Service -I (4360201)						
	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 principles, techniques, and practices involved in maintaining and servicing automobile engines*	3	2	2	3	2	2	3
a) Identify diagnostic tools and techniques used in engine condition diagnosis.	3	2		3	3	2	3
b) Inspect and service/repair of engine components for signs of wear, damage, or malfunction.	3	2	2	2	2		3
c) Identify the root cause of fuel supply system issues accurately.	3	2		2	2		2
d) Inspect and service/repair of engine cooling system and lubricating system effectively.	3	2		2	2		2
e) Rebuild and overhaul engines for optimal performance and reliability.	3	2	2	2		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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