

GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

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

Semester -VI

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

(Course Code: 4360202)

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

1. RATIONALE

The Maintenance and Service-II course is meticulously designed to impart students with comprehensive skills and knowledge needed to systematically troubleshoot, diagnose, and maintain vehicle transmission systems. This course places a premium on safety practices, operational efficiency, and the sustained reliability of automotive transmission systems. It serves as a foundational training for students aspiring to pursue careers in automotive maintenance and repair. Malfunction of the transmission system can lead to accidents and costly repairs. Educating students about maintenance practices ensures that transmission components are regularly checked, preventing potential failures and enhancing overall vehicle safety and reliability. A well-maintained transmission system can contribute to better fuel efficiency and reduced emissions. For students interested in starting their own automotive repair businesses or providing services independently, knowledge of transmission system troubleshooting and maintenance is vital. Assessment will encompass a multifaceted approach, including practical demonstrations, hands-on exercises and written examinations. This comprehensive evaluation ensures that students not only grasp theoretical concepts but can also apply their knowledge effectively in practical situations.

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.

- Troubleshoot vehicle transmission system problems systematically and safely.
- Maintain Transmission system efficient and reliable.

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) Acquire the expertise to diagnose, troubleshoot and maintain clutch and fluid coupling systems using appropriate tools, equipment and diagnostic techniques.
- b) Acquire the expertise to diagnose, troubleshoot and maintain gearbox and automatic transmission using appropriate tools, equipment and diagnostic techniques.
- c) Acquire the expertise to diagnose, troubleshoot and maintain propeller shaft, differential, universal joint, slip joints and axles using appropriate tools, equipment and diagnostic techniques.
- d) Acquire the expertise to diagnose, troubleshoot and maintain steering system suspension system and chassis using appropriate tools, equipment and diagnostic techniques.

- e) Acquire the expertise to diagnose, troubleshoot and maintain braking system, wheels and tyre using appropriate tools, equipment and diagnostic techniques.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				Total Marks
L	T	P		Theory Marks		Practical Marks		
			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	Perform Inspection procedure of clutch components for wear, misalignment, damage with the help of diagnostic tool and carry out corrective measures.	Any one	1	04
2	Check fluid coupling for lubrication and alignment and carry out corrective measures.		1	04
3	Carry out routine maintenance, inspection and servicing of Manual gearbox.	Any one	2	04
4	Carry out routine maintenance, inspection and servicing of Automatic Transmission.		2	04
5	Carry out inspection and servicing of final drive.		3	04
6	Carry out inspection and servicing of Power steering system.	Any one	4	04
7	Carry out inspection and servicing of suspension system.		4	04
8	Carry out Wheel alignment.		4	04
9	Carry out inspection and servicing of braking system (Any one-Mechanical or Hydraulics or Pneumatic)	Any two	5	04
10	Perform Bleeding Procedure of Hydraulic Brakes.		5	04
11	Carry out tyre rotation process and wheel balancing.		5	04
	Total Hrs.			28

Note

- *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.*

- 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.
- 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.

Sr. No.	Sample Performance Indicators for the Practical	Weightage in %
1	Knowledge of assigned practical.	25
2	Adherence to Safety regulations and the necessary method.	25
3	Performance in question-answer session.	25
4	Submission of work considering quality and time limit.	25
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	Dial Gauge, feeler gauge and straight edge gauge, clutch aligner, Bearing puller, different types of hand tools and power tools.	All
2	Hydraulic Jack (2 Tons Capacity) with 4-Stands 1.5 Tons Capacity	All
3	Hydraulic Two Post Car Lift <ul style="list-style-type: none"> • Max Load : 2- 4 Tons • Locking System : Automatic • Phase Type : Single Phase • Lifting Time : 41- 50 Sec • Max. lifting height : 1830 mm 	All
4	Different types Clutch unit component assembly like Single plate, multiplate and centrifugal clutch with actuating mechanisms.	01
5	Fluid coupling assembly and its components.	02
6	Working model of different types of gear box units (sliding mesh, constant mesh, synchromesh gearboxes) with actuating mechanism.	03
7	Working model of different types of Automatic gear box Units (CVT, AMT and DCT / DS)	04
8	Working model of Rear axle with differential unit and final drive.	05
9	Working Model of power steering mechanism (Hydraulic and Electric assisted)	06

10	Working model of various suspension systems like leaf spring, shock absorber, independent suspension and air suspension.	07
11	<p>Wheel alignment unit.</p> <p>Technical Specifications:</p> <ul style="list-style-type: none"> • Toe = ± 20 • Camber = ± 10 • Caster = ± 30 • Setback = ± 20 • Thrust Angle = ± 10 • Power Supply = 230Volt • Power Consumption = 0.4kw • Intelligent Round Moving guided led. • No electronic components and sensor. • No periodic calibration with one. • High precision wheel alignment 3D. • Low-cost maintenance with lower failure rate. • Parking Assistant. • Unique High-resolution targets. • High resolution camera. • User friendly software and quick alignment. • Standard 10" to 24" wheel clamps • Automatic steering angle Measurement without expensive electronic turn tables • Mounting kit for clamps and targets. • Platinum Software • Cabinet with 32" Led 	08
12	Working model of various braking systems like Hydraulic and pneumatic.	09,10
13	<p>Automatic Tyre Charger Machine</p> <ul style="list-style-type: none"> • Motor Power 1.1kW • Air Requirement 8 – 10 bar • Internal Rim Clamping 12"- 23" • External Rim Clamping 10"- 20" • Bead Breaker Tire Width 3"- 15" • Maximum Tire Diameter 41" • Power Supply Single Phase 	11
14	<p>Automatic Wheel Balancing machine</p> <ul style="list-style-type: none"> • Type of Vehicle : Cars • Usage/Application : wheel balancing of Cars, bikes • Rim Width : 1.5 -20" • Motor Power : 0.25kw • Power Supply : 220V • Rim Diameter : 10"-24" • Automation Grade : Automatic • Max Wheel Diameter 24" • Type Video-graphic 	11

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 fulfill 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.

<u>Unit</u>	<u>Unit Outcomes (UOs)</u> (4 to 6 UOs at different levels)	<u>Topics and Sub-topics</u>
Unit I Trouble shooting of Clutch and Fluid coupling	1.a Identify problems while engaging and disengaging clutch with remedial actions. 1.b Troubleshoot clutch problems on the basis of feel and noise. 1.c Inspect clutch components for damage. 1.d Carryout test and measurement required for clutch effective operation. 1.e Carry out clutch adjustments. 1.f Troubleshoot basic problems in fluid coupling.	1.1 Problem Identification in clutch engagement and disengagement, clutch pedal linkages and clutch release mechanism and corrective actions. 1.2 Troubles and their remedial measures for clutch unit on the basis of feel and noise such as clutch drag, clutch pedal pulsation, clutch judder, clutch chatters, clutch linkages vibration and noisy, clutch stiff and clutch slip with their causes and remedial actions. 1.3 Inspection of clutch components like release bearing, flywheel, pressure plate and clutch plate for wear, tear, scoring and chatters according to various problems. 1.4 Testing of clutch components like Pressure plate warpage test, clutch plate and flywheel run-out measurement and reconditioning steps. 1.5 Different types of Clutch adjustments with free play adjustment. 1.6 Trouble shooting in fluid coupling such as slip/drag, fluid leakage and low fluid level with its causes and remedial actions.

<p>Unit II Trouble shooting of Gearbox and Transmission system components</p>	<p>2.a Identify and address diverse gearbox issues. 2.b Identify and address diverse Automatic gearbox issues. 2.c Identify and address diverse torque convertor issues. 2.d Carry out comprehensive maintenance and servicing of gearbox. 2.e Understand the environmental impact with an emphasis on proper disposal practices.</p>	<p>2.1 Various troubles in Gearbox like hard shifting, Gear slipping, Noisy gear engagement, grinding noises during gear changes and oil leakages with their causes and remedial actions. 2.2 Various troubles in Automatic transmission such as Low or leaking fluid, Gears slipping and various noises with their causes and remedial actions. 2.3 Identify various troubles in Torque Convertor such as lock-up, overheating and unusual noises with their causes and remedial actions. Stall test of torque convertor. 2.4 Maintenance and servicing: 2.4.1 Fluid Inspection and Change 2.4.2 Identifying and replacing worn or leaking seals. 2.4.3 Checking for worn or damaged bearings in the transmission. 2.4.4 Visual inspection of gears and synchronizers for wear or damage. 2.4.5 Lubricating and adjusting the gear linkage for smooth operation. 2.4.6 Servicing and maintenance of automatic transmission. 2.4.7 Environmental Impact: Proper disposal of transmission fluids and components.</p>
<p>Unit III Trouble shooting of Driveline and Axles (Front & Rear Axles)</p>	<p>3.a Diagnose problems related to propeller shaft and universal joint and suggest remedial actions on the basis of cause. 3.b Diagnose problems related to differential and suggest remedial actions on the basis of cause. 3.c Diagnose problems related to front axle and rear axle and suggest remedial actions on the basis of cause. 3.d Carry out Inspection, servicing and reconditioning of front axle assembly. 3.e Carry out Inspection, servicing and reconditioning of rear axle assembly.</p>	<p>3.1 Various troubles in Propeller shaft and universal joints such as vibration, noise and misalignment with their probable causes and remedial actions. 3.2 Differential problems on the basis of abnormal noise and vibration, fluid leakage and Differential locking. 3.3 Various troubles in front axle and rear axle assembly with its probable causes and remedial actions. 3.4 Inspection, servicing and reconditioning of front axle assembly. 3.5 Inspection, servicing and reconditioning of rear axle assembly.</p>

<p>Unit IV Trouble shooting of Steering system, Suspensions and chassis.</p>	<p>4.a Diagnose problems in steering system and suggest remedial action. 4.b Carry out inspection and servicing of steering system. 4.c Understand procedure of wheel alignment. 4.d Diagnose problems in suspension system and suggest remedial action. 4.e Inspect and overhaul suspension system components. 4.f Understand procedure of chassis greasing.</p>	<p>4.1 Various troubles in steering system (Power steering systems) with its probable causes and remedial actions. 4.2 Inspection, servicing and reconditioning of steering systems and steering gearbox according to problems. 4.3 Wheel alignment procedure. 4.4 Various troubles indifferent types of suspension systems like shock absorber, leaf spring, independent suspension and air suspension with its probable causes and remedial actions 4.5 Inspection and overhauling of suspension systems according to problems. 4.6 Chassis greasing procedure using grease gun.</p>
<p>Unit V Trouble shooting of Brakes & Service of Wheels and Tyres</p>	<p>5.a Diagnose problems related to drum brake and suggest remedial actions on the basis of cause. 5.b Diagnose problems related to disc brake and suggest remedial actions on the basis of cause. 5.c Diagnose problems related to air brake and suggest remedial actions on the basis of cause. 5.d Understand procedure of air bleeding process and brake performance test. 5.e Troubleshoot problems of wheels and tyres. 5.f Understand procedure of inspecting wheels and tyres, tyre retreading and wheel balancing.</p>	<p>5.1 Drum brake troubleshooting such as Brake pedal goes to the floor, One brake drags, All brake drags, Pulls to one side when braking, Soft or spongy pedal, Poor braking required excessive pedal force, Brakes grab, Noisy brakes, Loss of brake fluid, Brakes do not self-adjust, Brake warning light while braking. 5.2 Disc brake troubleshooting such as Excessive pedal travel, Pedal pulsations Excessive pedal. force, grabbing, uneven braking, Pulls to one side while braking, Brake noise, Brake fails to release, Fluid leaking from caliper, Front disc caliper grab, No braking with pedal fully depressed, fluid level low in master cylinder. 5.3 Troubleshooting of Air braking system 5.4 Air bleeding procedure for brakes and Brake performance test 5.5 Troubleshooting of Disc Wheels, Alloy wheels and Tyres. 5.6 Important Procedures for, a. Inspection of Wheel Rim and Tyres b. Tyre Retreading procedure c. Wheel balancing procedure</p>

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	Trouble shooting of Clutch and Fluid coupling	5	3	4	7	14
II	Trouble shooting of Gearbox and Transmission system components	6	3	4	7	14
III	Trouble shooting of Driveline and Axles (Front & Rear Axles)	5	3	4	7	14
IV	Trouble shooting of Steering system, Suspensions and chassis.	6	3	4	7	14
V	Trouble shooting of Brakes & Service of Wheels and Tyres	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 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.
- 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 chart showing troubleshooting of clutch.
2) Prepare a display of different worn or damaged parts of clutch.
3) Prepared a chart of Trouble shooting in fluid coupling
4) Prepare a chart showing troubleshooting of manual Gear box and automatic gear box.
5) Prepare a chart on different Gear tooth wear pattern with its symptoms
6) Prepare a display of different worn or damaged parts of manual gearbox and automatic transmission with its actuating mechanism
7) Prepare chart of trouble shooting of drivelines and axles
8) Prepared a model of rear axles and differential unit for wear and run out measurement
9) Prepare chart of trouble shooting of Steering Systems (Hydraulics and Pneumatics)
10) Prepare a display of different worn or damaged parts of steering linkages and steering gearbox
11) Prepare chart of trouble shooting of Various Suspension system (leaf springs, independent suspension, air suspension)
12) Prepare chart on various wheel alignment machine with its specification
13) Prepare chart on various chassis lubrication points and its lubrication procedure
14) Prepare chart on trouble shooting of various braking systems (Mechanical, hydraulic and pneumatic)
15) Prepare a display prototype model of Bleeding procedure of hydraulics brake
16) Prepare a chart on wheel balancing steps and wheel rotation procedure
17) Prepare chart of trouble shooting of wheels and tyres.
18) Prepare a chart of tyre retreading procedure.
19) Prepare a model of tyres with its different wear condition.

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, Noida, UP, India (2017) ISBN-13: 9780070634350
2	Automotive Technology	James Halderman	Pearson Publication, Noida, UP, India (2019) ISBN-10: 0-13-254261-7 ISBN-13: 978-0-13-254261-6
3	Vehicle Maintenance And Garage Practice	Jigar A. Doshi, Dhruv U. Panchal, Et Al.	PHI Learning, Delhi, India (2014) ISBN : 9788120349827
4	Automobile Engineering	R. B. Gupta	Satya Prakashan, New Delhi (2016) ISBN : 9788176848589, 8176848581
5	Maintenance Engineering And Management	R. C. Mishra, K. Pathak	PHI Learning Pvt. Ltd., Delhi, India (2004) ISBN : 9788120345737
6	Automobile Engineering, Vol.1, (Chassis And Body)	Dr. Kirpal Singh	Standard Publishers Distributors, India (2007) ISBN : 8180140997
7	Automotive Technology	N. K. Giri	Khanna Publication Co. (P) Ltd., Delhi, India (2004) ISBN : 8174092161
8	Automobile Engineering	C. P. Nakra	Dhanpat Rai Publication Co. (P) Ltd., Delhi , India (2023) ISBN-10 : 9352168828 ISBN-13 : 978-9352168828

14. SOFTWARE/LEARNING WEBSITES

- a) <https://www.howacarworks.com>
- b) <https://swayam.gov.in>
- c) <https://auto.howstuffworks.com>
- d) <https://nptel.ac.in/courses>
- e) <https://tinyurl.com/4npz2sez> (Video Link)
- f) <https://tinyurl.com/238z958y> (Web Link)

15. PO-COMPETENCY-CO MAPPING

Semester VI	Maintenance & Service -II (4360202)						
	POs						
Competency & Course Outcomes	PO 1 Basic & Discipline specific knowledge	PO 2 Problem Analyses	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
<ul style="list-style-type: none"> Troubleshoot vehicle transmission system problems systematically and safely. 	3	3	1	3	2	3	3
<ul style="list-style-type: none"> Maintain Transmission system efficient and reliable. 	3	3	1	3	2	3	3
a) Acquire the expertise to diagnose, troubleshoot, and maintain clutch and fluid coupling systems using appropriate tools, equipment, and diagnostic techniques.	3	3	1	3	2	3	3
b) Acquire the expertise to diagnose, troubleshoot, and maintain gear box and automatic transmission using appropriate tools, equipment, and diagnostic techniques.	3	3	1	3	2	3	3
c) Acquire the expertise to diagnose, troubleshoot, and maintain propeller shaft, differential, universal joint, slip joints and axles using appropriate tools, equipment, and diagnostic techniques.	3	3	1	3	2	3	3
d) Acquire the expertise to diagnose, troubleshoot, and maintain steering system suspension system and chassis using appropriate tools, equipment, and diagnostic techniques.	3	3	1	3	2	3	3
e) Acquire the expertise to diagnose, troubleshoot, and maintain braking system, wheels and tyre using appropriate tools, equipment, and diagnostic techniques.	3	3	1	3	2	3	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
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4	Mr. M. J. Gohil Lect. Automobile	Sir B.P.T.I, Bhavnagar	9712276060	mjgautodept@gmail.com
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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
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