

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

Semester –IV

**Course Title: Recent Trends in Automobile**

(Course Code: 4340203)

Diploma programme in which this course is offered	Semester in which offered
Automobile Engineering	4 <sup>th</sup> Semester

**1. RATIONALE**

Current trends in the automobile industry show that information-centric technology will be crucial to the development of the automotive sector. At a never-before-seen rate, the sector is incorporating new technologies into its operations. Better engine management systems and electronic controls are recent trends that are focusing on improving overall engine performance, transmissions, drivability and road safety. This course seeks to acquaint students with current developments in automotive engine systems, transmission systems, electrical systems, alternative fuels, and safety features.

**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.

- **Describe advancement in automotive system and alternative fuels.**

**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) Describe engine management system and various advance engine technology.
- b) Describe advance vehicle transmission, braking and control system and technologies.
- c) Describe advance vehicle starting, lighting, infotainment, communication and driver assists technologies.
- d) Compare working mechanism of Compress Natural Gas (CNG), flex-fuel and hydrogen-based fuel cell.
- e) Describe importance of vehicle crash test and safety system.

#### 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	
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	Interpret working and mechanism of engine force induction system using turbocharger for 4- stroke petrol/diesel engine.	Any one	I	04
2	Compare natural aspire engine and turbocharged engine for same cylinder capacity on basis of engine power, torque, fuel efficiency and prepare engine specification list.		I	04
3	Describe the gear selection procedure and gear steps in the epicyclic gear box.	Any two	II	04
4	Interpret working procedure of the gear shift knob and link mechanism used in epicyclic, CVT, DSG and AGS gearbox.		II	04
5	Compare working and performance of hydraulic/pneumatic braking system with and without the Anti-Lock Braking (ABS) system.		II	04
6	Compare working principle of various modern starting system of Brushless ACG starter system, Engine keyless (button) start/stop system, Ideal engine start-stop system and remote vehicle ignition system (starting system)	Any one	III	04
7	Select any one Indian car manufacturer brand and model, prepare the list of latest features available in the car. Prepare brief report regarding any five features of the car		III	04

	about describe its mechanism/working/technology involved in it.			
8	Compare the constructional difference between flex-fuel supply system and petrol-diesel based fuel supply system (BS-IV & BS-VI) for vehicle.	Any one	VI	04
9	Compare advantages and limitations of petrol/diesel, flex-fuel and hydrogen-based fuel-cell technologies in-terms of performance, adaptability, affordability, impact on reduction of greenhouse emission gases etc.		VI	04
10	Draw the layout, installation and working procedure of sequential, indirect and direct CNG fuel supply system.		VI	04
11	List various type of vehicle crash test human dummy and classify them according to age group of human dummies.	Any one	V	04
12	Describe any one Indian car manufacturer brand and model crash test safety rating according to Global NCAP car crash test data and learn to interpretate test result.		V	04
13	Select any one Indian car manufacturer brand and model, prepare list of crash test performed on car during the vehicle crash lab test, list protocols referred for the crash test and crash test result data report by refer Global NCAP test report available on Global NCAP website.		V	04
<b>Total Hrs.</b>				<b>28</b>

**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 (Practical 1 to 10)	Weightage in %
1	Differentiate between conventional and advancement in automotive systems.	40%
2	Prepare neat sketch, layout with name of component.	20%
3	Answer to question.	20%
4	Timely completion of tasks.	20%

<b>Total</b>	<b>100%</b>
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<b>S. No.</b>	<b>Sample Performance Indicators for the Practical's (Practical 11 to 13)</b>	<b>Weightage in %</b>
1	Understanding of practical aim.	40%
2	Interpret crash test data.	20%
3	Answer to question.	20%
4	Timely completion of tasks.	20%
<b>Total</b>		<b>100%</b>

## 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	Cut section model of various type of supercharger and turbocharger used in petrol & diesel engine. Complete unit and its components are coated with attractive color for identify various parts and assembly. Cut-section model should be mounted on wooden or M.S. stand.	1
2	Chart board/demonstration board of Engine Management System operation and working and technological advancement in petrol & diesel fuel-based engines.	1,2
3	Cut section model of Epicyclic Gearbox This is made out of original car gearbox, suitably sectioned to show the details of gear mechanism of forward and reverse speeds. A crank lever is provided to demonstrate the mechanism. Complete unit is mounted on a sturdy iron frame.	3
4	Cut section model of Automatic gearbox/CVT This is made out of original car gearbox, suitably sectioned to show the details of gear mechanism of forward and reverse speeds. A crank lever is provided to demonstrate the mechanism. Complete unit is mounted on a sturdy iron frame.	4
5	Cut section Model of torque convertor This should be made out of original torque convertor assembly to dismantle and assembly and the whole unit mounted on a strong steel stand.	4
6	Cut section /Demonstration Model of different types of Brake (Drum, Disc, hydraulics and Air brake) A Hydraulic Brake working model unit consisting of master cylinder with brake oil reservoir bottle can be operate by a pedal for demonstration. Air brake working model unit consisting of Compressor with Air Brake reservoir/Tank can be operated by a pedal for demonstration.	5
7	Demonstration board of fuel supply system (MPFI/TSI/GDI) used in four stroke petrol engines (BS-IV or BS-VI) with requirements mentioned in following points. <ul style="list-style-type: none"> <li>• Original components of fuel supply system are mounted on a panel. All the components are labelled for better understanding. An electric motor driven system is supplied to demonstrate fuel delivery system.</li> <li>• Demonstration board should have following components: <ul style="list-style-type: none"> <li>- Sensors:- lambda sensor, engine speed sensor,</li> </ul> </li> </ul>	7

	<p>cam position sensor, throttle position sensor, mass air flow sensor, intake manifold pressure sensor etc.</p> <ul style="list-style-type: none"> <li>- Inlet manifold with pressure gauge/sensor.</li> <li>- Fuel filters</li> <li>- Fuel injector</li> <li>- Throttle body</li> <li>- Canister purge valve</li> <li>- Electronic control unit and fuel supply system electric and electronic wiring harness.</li> <li>- Small fuel tank</li> <li>- Primary &amp; secondary fuel pump</li> <li>- Fuel rails</li> <li>- Fuel hoses</li> </ul> <p>Fuel injector sequence simulator with variable speed drive.</p>	
8	<p>Demonstration board of CNG fuel supply system used in four stroke petrol engines (BS-IV or BS-VI) with requirements mentioned in following points.</p> <ul style="list-style-type: none"> <li>• Original components of fuel supply system are mounted on a panel. All the components are labelled for better understanding. An electric motor driven system is supplied to demonstrate fuel delivery system. <ul style="list-style-type: none"> <li>- CNG filling valve</li> <li>- CNG storage tank</li> <li>- Cylinder valve</li> <li>- Pressure regulator</li> <li>- Filter</li> <li>- Gas temperature and pressure sensor</li> <li>- Electronic control unit</li> <li>- Injector</li> <li>- Injector rail</li> <li>- Gas level indicator</li> <li>- Changeover switch</li> <li>- High pressure and low-pressure pipe</li> </ul> </li> </ul>	9
9	<p>Chart board/demonstration board for Different Car Crash Test Performed on vehicle human dummy used in tests with some example of vehicle safety ratings.</p>	10,11,12

## 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 1<sup>st</sup> year
- ii. 'Organization Level' in 2<sup>nd</sup> year.
- iii. 'Characterization Level' in 3<sup>rd</sup> 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
<b>Unit I</b> Advancement in engine system.	1.a Define the engine management system. 1.b Compare natural aspired engine & force induction system-based engine performance and parameters. 1.c Describe the working mechanism of various advance engine technology.	1.1 Requirement, function and working of engine management system. <ul style="list-style-type: none"> <li>- Speed density method.</li> <li>- Closed loop lambda control.</li> </ul> 1.2 Basic principle of force induction system. 1.3 Construction detail and working procedure of force induction system. <ul style="list-style-type: none"> <li>- Supercharger.</li> <li>- Turbocharger, turbolag, wastegate valve, variable geometry turbocharger, twin turbocharger.</li> </ul> 1.4 Introduction in brief following advance engine technology. <ul style="list-style-type: none"> <li>- DTSI</li> <li>- TSI</li> <li>- TDI</li> <li>- HCCI Engines – construction and working</li> <li>- VVT-i(Variable Valve Timing-intelligent)</li> </ul>

		<ul style="list-style-type: none"> <li>- Blue core technology</li> <li>- Variable compression ratio engines</li> </ul>
<b>Unit II</b>  Advancement in Transmission system	2.a Define requirement of the automatic transmission system in vehicle 2.b Compare constructional and working details of manual and automatic transmission system. 2.c Classify various transmission system available in the vehicles on basis of working and constructional details. 2.d Describe requirement and importance of various electronic control based modern vehicle braking technologies. 2.e Describe importance of vehicle electronic stability control system and run flat tyre system.	2.1 Introduction and types of automatic transmission system. 2.2 Basic working principle and construction details of epicyclic gearbox. 2.3 Basic working principle and constructional details of Continuous Variable Transmission (CVT). 2.4 Basic working principle and constructional details of the following electronic control based automatic transmission technology: <ul style="list-style-type: none"> <li>- DSG (Direct Shift Gearbox)</li> <li>- AGS (Auto Gear Shift) with ordinary clutch system.</li> <li>- AGS (Auto Gear Shift) with torque convertor.</li> </ul> 2.5 Function and working mechanism of following electronic control based modern vehicle braking and control technologies. <ul style="list-style-type: none"> <li>- Antilock Braking System.</li> <li>- Electronic Brake Force Distribution with Antilock Braking System (EBD + ABS).</li> <li>- Automatic Emergency Braking System (AEB).</li> <li>- Hill Hold and Hill Decent Control system.</li> <li>- Traction control system</li> </ul> 2.6 Introduction of the vehicle electronic stability control system. 2.7 Introduction in brief about run flat tyre.



<p><b>Unit III</b></p> <p>Advancement in Electrical and Electronics system</p>	<p>3.a Describe function and working of modern vehicle starting system.</p> <p>3.b Describe working of advance vehicle lighting system.</p> <p>3.c Select appropriate mobile communication technology-based vehicle connectivity and infotainment system.</p> <p>3.d Describe working and function of driver assists technology and features available in the modern vehicle.</p> <p>3.e Describe Autonomous/ self-driving vehicle technology.</p>	<p>3.1 Function and working of following modern vehicle starting system</p> <ul style="list-style-type: none"> <li>- Brushless ACG starter system. (silent/noiseless engine starting system).</li> <li>- Engine keyless (button) start/stop system.</li> <li>- Ideal engine start-stop system.</li> <li>- remote vehicle ignition system (starting system).</li> </ul> <p>3.2 Function and working of following advance vehicle lighting system.</p> <ul style="list-style-type: none"> <li>- HID (High Intensity Discharge) head light.</li> <li>- Automatic head lamps.</li> <li>- LED fog light.</li> <li>- Adaptive LED front head light system.</li> <li>- High beam assist system.</li> <li>- LED turn indicators, backlight warning light system.</li> </ul> <p>3.3 Introduction of mobile communication technology-based vehicle connectivity and infotainment system.</p> <p>3.4 Function and working of following driver assist technologies and features.</p> <ul style="list-style-type: none"> <li>- Adaptive Cruise Control (ACC).</li> <li>- Advanced Driver Assistance Systems (ADAS).</li> <li>- Lane departure prevention.</li> <li>- Blind spot detection.</li> <li>- Front collision warning.</li> <li>- Tyre Pressure Monitoring System (TPMS).</li> <li>- Parking assist.</li> <li>- Head-up display.</li> </ul>
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		<ul style="list-style-type: none"> <li>- 360° view camera.</li> <li>- Electronic anti-glare mirrors.</li> <li>- Vehicle overspeed warning.</li> <li>- Speed sensing door lock.</li> <li>- Ventilated seats.</li> <li>- Smart air purifier with virus protection.</li> </ul> <p>3.5 Introduction in brief on Autonomous/ self-driving vehicle technology.</p>
<p><b>Unit IV</b></p> <p><b>Green fuels</b></p>	<p>4.a Describe working and operation of Compress natural Gas based fuel supply system, flex-fuel technology and hydrogen-based fuel-cell technology.</p> <p>4.b Identify parts and components of Compress natural Gas based fuel supply system, flex-fuel technology and hydrogen-based fuel-cell technology and define the purpose of each.</p> <p>4.c State importance and advantages of adopting low greenhouse gas emission based alternative fuel supply system for SI and CI engine.</p>	<p>4.1 Introduction in brief about Compress Natural Gas (CNG) fuel supply system use in the four stroke petrol engines.</p> <p>4.2 Layout overview of CNG sequential indirect and direct fuel supply system.</p> <ul style="list-style-type: none"> <li>- List the major components of CNG supply system and state function and working detail of each component.</li> <li>- State importance of CNG cylinder testing and describe CNG cylinder testing method.</li> </ul> <p>4.3 Introduction of the flex-fuel supply system for spark ignition engine.</p> <p>4.4 Introduction of the hydrogen-based fuel-cell technology for vehicle.</p> <p>4.5 Working principle, layout and list major components of hydrogen-based fuel-cell vehicle.</p> <p>4.6 Introduction of hydrogen internal combustion engine vehicle (HICEV).</p>
<p><b>Unit V</b></p> <p><b>Vehicle safety system</b></p>	<p>5.a State importance of vehicle safety.</p> <p>5.b Classify vehicle safety and parameter related to vehicle safety.</p>	<p>5.1 Introduction, importance and requirement of the vehicle crash safety.</p> <p>5.2 Vehicle active safety and passive safety.</p>

	<p>5.c List various vehicle crash test agencies, vehicle safety standards and safety rating.</p> <p>5.d Interpret vehicle safety rating and classify vehicle on based of safety rating.</p> <p>5.e Describe working of vehicle safety system and various components like airbag and seat belt etc.</p> <p>5.f State importance of ISOFIX for child occupant safety.</p>	<p>5.3 Introduction of the vehicle safety test agencies mentioned in following list:</p> <ul style="list-style-type: none"> <li>- New Car Assessment Programs (NCAP)</li> <li>- Global NCAP</li> <li>- Federal Motor Vehicle Safety Standards (FMVSS)</li> <li>- Insurance Institute for Highway Safety (IIHS)</li> <li>- National Highway Traffic Safety Administration (NHSTA)</li> </ul> <p>5.4 Concept of the vehicle crash test.</p> <p>5.5 Types of the vehicle crash tests are involved in the vehicle safety test.</p> <p>5.6 Working principle, mechanism and constructional details of the airbag, seat belt, seat belt pretensioner, seatbelt retractor.</p> <p>5.7 Importance and advantage of ISOFIX child seat system.</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	Advancement in engine system.	5	4	7	3	14
II	Advancement in Transmission system.	6	4	7	3	14
III	Advancement in Electrical and Electronics system.	5	4	7	3	14
IV	Green Fuels	7	7	4	3	14
V	Vehicle safety system	5	7	4	3	14
	<b>Total</b>	28	26	29	15	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) Visit any vehicle showroom and make comparative list of different features available in different models and variant of vehicle
2) Prepare report on supercharger
3) Prepare report on turbocharger
4) Visit CNG installation workshop and prepare report n installation process and tune-up process
5) Do literature survey on uses of hydrogen as fuel

6) Do literature survey on flex fuel technology
7) Visit 2 different vehicle show room and make comparative report on safety ratings of different models and variants
8) Prepare report on non-pneumatic tires and run flat tires.
9) Visit World Health Organization (WHO) website for asses latest “Global status report on road safety”. Prepare chart of showing vehicle road accident, injury and road accident death data.
10) Prepare chart or power presentation on basic working mechanism of any one advance engine technology used in the passenger car.
11) Prepare chart or power presentation on basic working mechanism of any one advance engine technology used in the two-wheeler.
12) Prepare chart of working procedure of single or double stage turbocharger and define, turbo-lag, wastegate valve, variable geometry turbocharger with help of photograph, demonstration components or diagram.
13) Prepare chart or power presentation on working of single planetary gear set and prepare gear selection and gear ratio data table.
14) Prepare demonstration model of CVT gear box working mechanism by using cardboard sheet, wood or steel sheet material and apply various color on it to indicate various components.
15) Prepare chart on working mechanism of the DSG gearbox.
16) Prepare demonstration model of semi-automatic or automatic gear selector knob with help of replica or scrapped gear selector knob components.
17) Prepare color printed chart for showing importance of the antilock braking system in the passenger and commercial vehicle, also show comparison results of vehicle with or without the antilock braking system.
18) Prepare power point presentation for explaining importance of advance electronic based braking system available in the latest car. (Include animation and audio-video clip in the presentation).
19) Prepare chart for describe working mechanism any one modern features available in the latest cars with help of color diagram and figures.

**13. SUGGESTED LEARNING RESOURCES**

<b>Sr. No.</b>	<b>Title of Book</b>	<b>Author</b>	<b>Publication with place, year and ISBN</b>
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	Automobile Electrical and Electronic Systems	Tom Denton	Routledge, 2017,5th edition, ISBN:978-0415725774
4	Alternative Fuels	S. S. Thipse	Jaico Publishing House ISBN:978-81-8495-078-6
5	Advanced Vehicle Technology	Heinz Heisler	Butterworth Heinemann ISBN: 0-7506-5131-8
6	Modern Vehicle Technology	James E. Duffy	Goodheart-Willcox ISBN: 978-1619603707

**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/4w73a254> for video link
- f) <https://tinyurl.com/5n93f6xv> for web link

**15. PO-COMPETENCY-CO MAPPING**

Semester IV	Recent Trends in Automobile (4340203)						
	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
<ul style="list-style-type: none"> <li>Describe advancement in automotive system and alternative fuels.</li> </ul>	03	02	01	02	02	02	03
a) Describe engine management system and various advance engine technology.	03				02		03
b) Describe advance vehicle transmission, braking and control system and technologies.	03	02	01	02			03
c) Describe advance vehicle starting, lighting, infotainment, communication and driver assists technologies.	03		01	02			03
d) Compare working mechanism of Compress Natural Gas (CNG), flex-fuel and hydrogen-based fuel cell.	03			02	02		03
e) Describe importance of vehicle crash test and safety system.	03	02		02		02	03

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	<a href="mailto:deven_a_dave@yahoo.co.in">deven_a_dave@yahoo.co.in</a>
2	Mr. D. V. Dhanak Lect. Automobile	Govt. Polytechnic, Ahmedabad	7016559132	<a href="mailto:dhnk.deep1985@gmail.com">dhnk.deep1985@gmail.com</a>
3	Mr. D. J. Gohel Lect. Automobile	C. U. Shah Polytechnic Surendranagar	9879428562	<a href="mailto:djgohel80@gmail.com">djgohel80@gmail.com</a>
4	Mr. H. V. Patel Lect. Automobile	Sir B.P.T.I, Bhavnagar	99788 72090	<a href="mailto:hvpautodept@gmail.com">hvpautodept@gmail.com</a>
5	Mr. N. R. Dave Lect. Automobile	C. U. Shah Polytechnic Surendranagar	7984370804	<a href="mailto:naitik.dave510@gmail.com">naitik.dave510@gmail.com</a>

**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	<a href="mailto:shyamvarghese@gmail.com">shyamvarghese@gmail.com</a>
2	Mr. A. K. Nanavati, HOD Automobile	Govt. Polytechnic, Ahmedabad	9426674409	<a href="mailto:aknanavati@gmail.com">aknanavati@gmail.com</a>