

GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)**Competency-focused Outcome-based Green Curriculum-2021 (COGC-2021)****Semester -III**Course Title: **Fuels and Pollution Control System**

(Course Code: 4330204)

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

1. RATIONALE

Fuels are the energy sources for vehicle and lubricants are used to reduce energy losses in vehicle. Quality of both affect engine performance and vehicle life where as their use is linked with environment sustainability and economy of nation. This course enables students to understand composition and properties of fuels and lubricants with reference to their performance in IC-engine. Due to different chemical composition different fuels behave differently during combustion process. Also their end products are different for different combination of parameters, like pressure, temperature, air etc. Combustion of Fuel generates exhaust gases, which pollutes the atmosphere. Due to exponential growth of automobiles, their emissions have become a social concern and engineers are supposed to reduce pollutants. Therefore students should have knowledge about the pollutants produced by automobiles and ways to reduce the pollution by the use of the various Emission control devices. This course will also provide opportunity to develop skills in measuring pollutions and maintain Emission control devices.

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.

- **Identify issues related to properties and additives of fuels and Lubricants in a vehicle.**
- **Select proper rectifying measures for polluting vehicle.**

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. Interpret the effect of various properties and additives of fuel on the function of the engine.
- b. Interpret the effect of various types of lubricants used in a vehicle based on their properties and additives.
- c. Determine the role of conventional fuel in combustion and causes as well as preventive measures for abnormal combustion.
- d. Analyze the work of various systems/components used in vehicle for pollution control.

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	
3	0	2	4	30*	70	25	25	150

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

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

5. SUGGESTED PRACTICAL EXERCISES

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

Sr. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. required
	Any two from following.		
1	Measure calorific value of given sample of fuel.	1	4
2	Measure viscosity of given sample of fuel and lubricant by viscometer.	1,2	4
3	Measure flash and fire point of given sample of fuel.	1	4
4	Measure volatility range of given sample of fuel.	1	4
5	Measure specific gravity of fuel. From that find out API gravity of sample.	1	4
	Any two from following.		
6	Measure cloud point and pour point of given sample of oil.	2	4
7	Measure carbon residue of given sample of oil.	2	4
8	Measure dropping point of given sample of grease.	2	4
9	Measure consistency of grease on rolling.	2	4
10	Measure penetration quality of grease.	2	4
	Any one from following		
11	Prepare and explain the chart of normal and abnormal combustion in SI engine and list out symptoms of abnormal combustion with preventive measure.	3	4
12	Prepare and explain the chart of normal and abnormal combustion in CI engine and list out symptoms of abnormal combustion with preventive measure.	3	4
	Any two from following		
13	Identify various emission control system in modern four wheeler, list them with the purpose.	4	4

14	Identify PCV system and EGR system replace it.	4	4
15	Identify catalytic converter, muffler and replace it.	4	4
16	Check emission level from car with the help of exhaust gas analyzer and compare with present norms of pollution limit.	4	4
17	Check emission level from car with the help of Diesel smoke meter and compare with present norms of pollution limit.	4	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 first year 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 PrOs	Weightage in %
1	Understanding of concept.	20
2	Explanation of purpose of doing given practical.	20
3	Skill with which he/she participate in practical work/data collection work.	30
4	Safety measures and/or accurateness followed by student while performing practical/ making chart	30
Total		100

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

S. No.	Equipment Name with Broad Specifications	Pra. No.
1	Bomb calorimeter/Junker's calorimeter/ Gas calorimeter	1
2	U tube viscometer/say bolt viscometer/red wood viscometer-1 and 2.	2
3	Pensky-martin/ Abel Flash and fire point apparatus	3
4	Fuel distillation plant.	4
5	West phal balance/ specific gravity bottle/Hydrometer	5
6	Cloud point and pour point apparatus	6
7	Carbon residual tester	7
8	Dropping point apparatus for grease	8
9	Grease roll stability test apparatus	9

10	Standard penetrometer for grease	10
11	SI engine	11
12	CI engine	12
13	Modern car	13
14	Cut section /separate system like PCV, EGR, muffler, catalytic converter, charcoal canister	14, 15
15	Exhaust gas analyzer	16
16	Diesel smoke meter.	17

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.

- Work as a leader/a team member.
- Follow ethical practices.
- Practice environmental 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:

- 'Valuing Level' in 1st year
- 'Organization Level' in 2nd year.
- '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 Conventional Fuels, their properties and additives.	1.a Compare various types of fuel. 1.b Understand Conventional fuels used in vehicle with respect to its requirements. 1.c Explain source, main constituents and characteristics of conventional fuel used in a vehicle. 1.d Explain various properties and additives of gasoline and	1.1 Fuel and its types with merits and demerits. 1.2 Basic requirement of IC-engine fuel. Conventional fuels used for vehicle (Gasoline and diesel – comparison) their source, main constituents. 1.3 Hydrocarbon- Its structure and composition. 1.4 Characteristics of Conventional fuel used in vehicle.

	<p>diesel and their impact on engine performance.</p> <p>1.e Explain rating of fuel.</p>	<p>1.5 Various desirable properties of SI engine fuels and their effect on engine performance</p> <p>1.6 Additives of gasoline (which and for what purpose)</p> <p>1.7 Various desirable properties of CI engine fuels and their effect on engine performance</p> <p>1.8 Additives of diesel (which and for what purpose)</p> <p>1.9 Rating of fuel: (1) Octane number (2) Cetane number</p>
<p>Unit – II</p> <p>Lubricants</p>	<p>2.a Explain role and classification of lubricating oil and grease used in a vehicle.</p> <p>2.b Appreciate properties and additives of lubricating oil and grease on their performance.</p> <p>2.c Understand grading of lubricating oil with respect to their application.</p> <p>2.d Determine the causes of deterioration of lubricants and grease.</p> <p>2.e Criticize Synthetic lubricants.</p> <p>2.f Understand factors to be considered while selecting grease.</p>	<p>2.1 Role of lubricating oil in a vehicle.</p> <p>2.2 Classification of lubricating oil on the basis of their use in a vehicle.</p> <p>2.3 Properties of lubricating oil and their effect.</p> <p>2.4 Grading of lubricating oil.</p> <p>2.5 Additives of lubricating oil (which and why basis)</p> <p>2.6 Causes of Oil degradation.</p> <p>2.7 Synthetic lubricants. Advantages and disadvantages of synthetic lubricants compare to conventional lubricants.</p> <p>2.8 Role of grease in a vehicle.</p> <p>2.9 Properties of grease used in a vehicle.</p> <p>2.10 Classification of grease on the basis of constituents.</p> <p>2.11 Additives of grease (on which and why basis)</p> <p>2.12 Causes of grease degradation</p> <p>2.13 Factors to be considered while selecting grease.</p>
<p>Unit – III</p> <p>Combustion Process in SI and CI engine.</p>	<p>3.a Describe the phenomenon of combustion in SI and CI engine and terminologies related to combustion process.</p> <p>3.b Analyze effect of factors responsible for abnormal combustion and ways to</p>	<p>3.1 Combustion in IC engine</p> <p>3.2 Effect of hydrocarbon structure and its composition on combustion.</p> <p>3.3 Normal and abnormal combustion in SI and CI engine.</p> <p>3.4 Factors responsible for abnormal combustion in SI and CI engine.</p>

	prevent abnormal combustion.	3.5 Ignition Lag and factors affecting it in SI and CI engine. 3.6 Pre-ignition and its effects. 3.7 Detonation in SI engine, its effects, factors affecting it and prevention. 3.8 Diesel knock, its effects, factors affecting it and prevention.
Unit IV Automotive emission, emission control systems and emission measurement.	<p>4.a Describe various pollutants produced under different driving conditions.</p> <p>4.b List Emission control components and draw layout of them in a vehicle.</p> <p>4.c Describe main construction details and working of various common emission control systems used in present vehicle.</p> <p>4.d Describe pollution control norms and its importance.</p> <p>4.e Explain emission Measurement methods for vehicle and compare with pollution norms.</p> <ol style="list-style-type: none"> 1. Exhaust gas analyzer 2. Diesel smoke meter 	<p>4.1 Theoretical air-fuel ratio</p> <p>4.2 Carbon monoxide (CO) gas.</p> <p>4.3 Hydro Carbon (HC) gas.</p> <p>4.4 Oxides of Nitrogen (NOx).</p> <p>4.5 Driving conditions and exhaust gases.</p> <p>4.6 Necessity and operation of Positive Crankcase Ventilation (PCV) system.</p> <p>4.7 Necessity and operation of fuel evaporative emission control (EVAP) system.</p> <p>4.8 Necessity and operation of Throttle Positioner (TP) system & Throttle Positioner sensor.</p> <p>4.9 Catalytic converters.</p> <p>4.10 Exhaust gas re-circulation (EGR) system.</p> <p>4.11 ECM controlled EGR valves.</p> <p>4.12 Necessity and operation of Mixture Control (MC) system.</p> <p>4.13 Pollution control norms and its importance.</p> <p>4.14 Emission measurement methods</p> <p>4.15 Exhaust gas analyzer</p> <p>4.16 Diesel smoke meter.</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	Distribution of Theory Marks				
		Teaching hours	R Level	U Level	A Level	Total Marks
I	Conventional Fuels, their properties and additives.	8	5	5	4	14
II	Lubricants	8	5	5	4	14
III	Combustion Process in SI and CI engine.	10	5	5	4	14
IV	Automotive emission, emission control systems and emission measurement.	16	10	10	8	28
	Total	42	25	25	20	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.
- With respect to **section No.10**, teachers need to ensure to create opportunities and provisions for *co-curricular activities*.
- 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:

Draw the layout of Emission control components.
Collect PUC of different vehicle and interpret the data.
Write down procedure of measuring pollutants from commercial centers.
Collect & compare data related to pollution norms of developed nations and India.
List out comparison of diesel and petrol on the basis of properties, price, structural changes and rating.
Write up /Presentation on Acid rain, Poisoning of animals and plants, Ozone depletion in the stratosphere, Climate change, and oil spill in oceans etc.
Plantation drive for green city.
Collect pollution data of your city for month and compare it with most polluted cities.
Report on what you can do to reduce pollutants as an Automobile engineer.
Visit any five petro/diesel pump station, collect the data of variety of petrol, diesel, engine performance enhancers available, their daily and monthly selling.
Report on data collection on type of lubricants and greases available at a shop with their application, special feature and cost.
Search answers related to questions like... <ol style="list-style-type: none"> 1. What if one use petrol in diesel engine 2. What if one diesel in petrol engine 3. Is petrol having higher octane number is best option with for all existing IC-engine

13. SUGGESTED LEARNING RESOURCES

Sr. No.	Title of Book	Author	Publication with place, year and ISBN
1	Fuels and Lubricants	M. Popovich and Carl Haring	Wiley, 1959 ISBN: 0471694657, 9780471694656
2	Internal Combustion Engines (4 TH EDITION-2017)	V. Ganesan	Tata McGraw-Hill Co., Ltd., New Delhi. ISBN: 9781259006197
3	Lubrication and Lubricants	J. H. Hyde	Sir I. Pitman & sons, Limited, 1922 ISBN-13: 978-1-332-02153-6 / 9781332021536.
4	Automobile Engineering (Vol- I)	Anil Chhikara	Satya Prakation, New Delhi ISBN-10 : 8176845051 ISBN-13 : 978-817684505
5	Automotive Emission Control	William H. Carouse Donald L. Anglina	Tata McGraw-Hill Co., Ltd., New Delhi ISBN-10 : 0070148163 ISBN-13 : 978-0070148161
6	Automotive Fuel and Emissions Control Systems	James D. Halderman, James Linder	Pearson; 3rd edition (20 January 2011) ISBN-10 : 0132542927 ISBN-13 : 978-0132542920

14. SOFTWARE/LEARNING WEBSITES

1. <https://www.howacarworks.com>
2. <https://swayam.gov.in>
3. <https://auto.howstuffworks.com>
4. <https://nptel.ac.in>
5. <https://tinyurl.com/5c3bp5a7> for video link
6. <https://tinyurl.com/ydanjbxy> for web link

15. PO-COMPETENCY-CO MAPPING

Semester III	Fuel and Pollution control system(4330204)						
	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
Competency <ul style="list-style-type: none"> Identify issues related to properties and additives of fuels and Lubricants in a vehicle. Select proper rectifying measures for polluting vehicle. 	3	3	2	3	3	2	3
a) Interpret the effect of various properties and additives of fuel on the function of the engine.	3	2	1	3	2	1	3
b) Interpret the effect of various types of lubricants used in a vehicle based on their properties and additives.	3	2	1	3	2	1	3
c) Determine the role of conventional fuel in combustion and causes as well as preventive measures for abnormal combustion.	3	3	2	1	2	1	3
d) Analyze the work of various systems/components used in vehicle for pollution control.	3	3	2	3	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**

Sr. No	Name and Designation	Institute	Contact No.	Email
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GTU BOS and Branch Co-ordinator Persons

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