# GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

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

II– Semester

Course Title: **Thermodynamics & Hydraulics**
(Course Code: 4320202)

| Diploma programme in which this course is offered | Semester in which offered |
|---|---|
| Automobile Engineering | 2nd |

## 1. RATIONALE

Heat energy is the basis for most of the power producing and power absorbing devices. In order to apply the principles of these devices, it is essential to inculcate the students with basic thermodynamics laws and thermodynamics process & cycles. Hydraulic system is widely used in automobile and its related industry. The course is intended to develop the basic understanding of thermodynamics, fluid behavior and its properties with its concept in the operation of automobile engines.

## 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 of thermodynamics and hydraulics in automotive system and equipments.**

## 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) Explain basic terminology and laws of thermodynamics.
b) Explain basic properties & principles of hydraulics.
c) Apply principles of thermodynamics and hydraulics in automotive system and equipment's.
d) Apply thermodynamics principles of waste heat recovery.

## 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 | |
| 3 | 1 | 0 | 4 | 30* | 70 | 0 | 0 | 100 |

*(*): 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

**Not Applicable**

## 6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

**Not Applicable**

## 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 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:

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)<br>(4 to 6 UOs at different levels) | Topics and Sub-topics |
|---|---|---|
| **Unit – I**<br>**Fundamentals of thermodynamics** | 1a Explain concept of thermodynamics system and thermodynamics properties.<br>1b Understand relevant laws of thermodynamics in given situation.<br>1c Explain various processes on P-V and T-S diagram.<br>1d Explain ideal gas and its laws.<br>1e Describe modes of heat transfer in automobile. | **1.1** Introduction to thermodynamics.<br>**1.2** Concept of thermodynamic system, surroundings and boundary.<br>**1.3** Thermodynamic properties.- pressure, Volume, Temperature Potential energy, kinetic energy, internal energy, heat- sensible heat and latent heat, Specific heat at constant pressure & specific heat at constant volume, work, Enthalpy, Entropy and their units. |

| | | |
|---|---|---|
| | . | **1.4** Thermodynamics equilibrium.<br>**1.5** State, path, processes and cycle.<br>**1.6** Laws of thermodynamics-Zeroth law, conservation of energy, first law of thermodynamics, Second law of thermodynamics-Kelvin Planks statement and Clausius statement.<br>**1.7** Represent constant pressure, constant volume, constant temperature, adiabatic and polytropic process on P-V and T-S diagram.<br>**1.8** Ideal gas and their basic laws.<br>**1.9** Introduction to modes of heat transfer and types of work. |
| **Unit –II**<br><br>**Fundamentals of Hydraulics** | **2a.** Define the given properties of fluid.<br>**2b.** Explain the types of fluid flow.<br>**2c.** Explain pascal's law.<br>**2d.** Describe concept of pressure and pressure measuring devices.<br>**2e.** Explain continuity equation and Bernoulli's theorem. | **2.1** Basic properties of fluid<br>**2.2** Types of fluid flow- Steady, unsteady, laminar, turbulent-, one-, two- and three-dimensional flow, uniform and non-uniform flow.<br>**2.3** Pascal's law<br>**2.4** Concept of atmospheric pressure, gauge pressure, vacuum, absolute pressure and pressure measuring devices.<br>**2.5** Law of continuity and its application.<br>**2.6** Bernoulli's theorem and its application such as Venturi meter, Orifice meter and pitot tube<br>**2.7** Pneumatics: definition, importance, areas of Applications and automotive applications. |
| **Unit –III**<br><br>**Applications of Thermodynamics and Hydraulics** | 3a Apply concept of heat engine, heat pump, refrigerator and heat exchangers.<br>3b Represent P-V and T-S diagram of Carnot cycle, | 3.1 Heat engine, Refrigerator, heat Pump, heat exchangers.<br>3.2 Air cycle: P-V and T-S diagram and equation for air standard efficiency of Carnot cycle, Otto cycle, Diesel cycle, Dual cycle. |

| | | |
|---|---|---|
| | Otto cycle, Diesel cycle and Dual cycle.<br>3c Apply concept and functional details of hydraulic devices and valve.<br>3d Describe functional details of pneumatic components. | 3.3 Concept and functional details of Hydraulic lift, hydraulic brakes, hydraulic steering, hydraulic jack, hydraulic shock absorber, loading-unloading devices, hydraulic tipping.<br>3.4 Valve- function, types and requirement, pressure control valve, pressure relief valve, pressure reducing valve, flow control valve, non-return/check valve.<br>3.5 Pneumatic Components - Air compressors its necessity, types reciprocating-diaphragm-vane compressor, requirement of multi stage compressors |
| **Unit– IV**<br>**Energy conservation and waste heat recovery** | 4a Describe energy conservation techniques of given situation.<br>4b Explain thermodynamics principles of waste heat recovery. | 4.1 Energy conservation: Definition, importance of energy conservation, impact on environment and economy.<br>4.2 Thermodynamics principles of waste heat recovery. |

***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 |
| 1 | **Fundamentals of thermodynamics** | **14** | **08** | **13** | **0** | **21** |
| 2 | **Fundamentals of Hydraulics** | **10** | **08** | **10** | **0** | **18** |
| 3 | **Applications of Thermodynamics and Hydraulics** | **14** | **00** | **08** | **13** | **21** |
| 4 | **Energy conservation and waste heat recovery** | **4** | **03** | **03** | **04** | **10** |
| | **Total** | **42** | **19** | **34** | **17** | **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:

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|---|
| Report writing on thermodynamics principles of waste heat recovery. |
| Report writing/poster on energy conservation in auto industry( literature survey) |
| Project work on data collection from market on different heat exchangers related to automobile. (It may include price/material of component) |
| Prepare charts on application of 2nd law of thermodynamics. |
| Give examples of thermodynamics system. |
| Project on motion with friction/motion without friction. |
| Comparative study on air compressor used in automotive workshops.(parameter – specification, price, specific use etc) |
| Comparative study on hydraulic jack used in automotive workshops.(parameter – specification, price, specific use etc) |
| Comparative study on hydraulic lift used in automotive workshops.(parameter – specification, price, specific use etc) |

## 13. SUGGESTED LEARNING RESOURCES

| S. No. | Title of Book | Author | Publication with place, year and ISBN |
|---|---|---|---|
| 1 | Thermodynamics | Dr D. S. Kumar | Publisher .S.K : Kataria & Sons; Reprint 2013 edition (1 January 2013)<br>ISBN-10 9380027664 :<br>ISBN-13 9380027661-978 : |
| 2 | Fluid Mechanics and Hydraulic machines | Dr. R. K. Bansal | Laxmi Publications; Tenth edition (1 January 2018)<br>ISBN-10 8131808157 :<br>ISBN-13 8131808153-978 : |
| 3 | Automobile Mechanics | William Crouse | Tata Mc-Graw Hill Publication<br>ISBN-13:978-0-07-063435-0 |
| 4 | Engineering Thermodynamics | R. K. Rajput | LAXMI PUBLICATIONS (P) LTD (1 January 2009)<br>ASIN B08LTKWKMY : |
| 5 | Thermal Science & Engineering | Dr D. S. Kumar | S.K. Kataria & Sons(Year 2020)<br>ISBN: 978-93-5014-428-2 |
| 6 | A Text book of thermal engineering | R S Khurmi,<br>JK Gupta | S. Chand Publishing<br>ISBN: 9788121925730 |

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|---|---|---|---|
| 7 | Energy management : conservation and audit | Anil kumar, Om Prakash, Prashant singh Chauhan and Samsher | CRC Press; 1st edition (28 July 2020) ISBN-13: **978-0367343835** |

## 14. SOFTWARE/LEARNING WEBSITES

a) https://www.howacarworks.com
b) https://swayam.gov.in
c) https://auto.howstuffworks.com
d) https://en.wikipedia.org
e) https://nptel.ac.in/courses/112/105/112105221

## 15. PO-COMPETENCY-CO MAPPING

| **Semester II** | **Thermodynamics & Hydraulics (Course Code: 4320202)** | | | | | | |
|---|---|---|---|---|---|---|---|
| | **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**<br>• Apply principles of thermodynamics and hydraulics in automotive system and equipments | 3 | 2 | 1 | | 2 | 2 | 3 |
| CO a) Explain basic terminology and laws of thermodynamics. | 3 | | | | | | 3 |
| CO b) Explain basic properties & principles of hydraulics. | 3 | | | | | | 3 |
| CO c) Apply principles of thermodynamics and hydraulics in automotive system and equipments. | 3 | 2 | | | 2 | 2 | 3 |
| CO d) Apply thermodynamics principles of waste heat recovery. | 2 | 2 | 1 | | 2 | 2 | 3 |

Legend: '**3**' for high, '**2**' for medium, '**1**' for low and '**-**' for no correlation of each CO with PO.

## 16. COURSE CURRICULUM DEVELOPMENT COMMITTEE

### GTU Resource Persons

| S. No | Name and Designation | Institute | Contact No. | Email |
|---|---|---|---|---|
| 1 | Mr. D. A. Dave (Retd. HOD Automobile) | Sir BPTI Bhavnagar | 9427182407 | deven_a_dave@yahoo.co.in |
| 2 | Mrs. M. N. Vibhakar Lect. Automobile | C. U. Shah Polytechnic Surendranagar | 9428868859 | mpp3668@hotmail.com |
| 3 | Mr. D. J. Gohel Lect. Automobile | C. U. Shah Polytechnic Surendranagar | 9879428562 | djgohel80@gmail.com |
| 4 | Mr. A. C. Suthar Trainer | Trainer Gallops Hyundai Ahmedabad | 9725061780 | autoengineeralpesh@gmail.com |

### GTU BOS and Branch Co-ordinator Persons

| S. No | Name and Designation | Institute | Contact No. | Email |
|---|---|---|---|---|
| 1 | Mr. Shyam Varghese HOD Automobile Branch Co-ordinator | Govt. Polytechnic, Ahmedabad | 94263 96640 | shyamvarghese@gmail.com |
| 2 | Mr. A. K. Nanavati, HOD Automobile | C. U. Shah Polytechnic Surendranagar | 9426674409 | aknanavati@gmail.com |