GUJARAT TECHNOLOGICAL UNIVERSITY (G.T.U.)

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

Course Title: Engineering Thermodynamics
(Course Code: 4331902)

Diploma programs in which this course is offered	Semester in which offered
Mechanical Engineering , Mechatronics Engineering, Marine Engineering	Third

1. RATIONALE:

Thermodynamics is a branch of science that deals with energy transformations and are primarily concerned with the two forms of energy heat and work. The energy transformations are governed by the various laws of thermodynamics known as zero, first, second and third laws. These laws were deducted from experimental observations and logical reasoning. Extensive applications of thermodynamics can be found in fields ranging from refrigeration and air-conditioning to aerospace. Its principles are used to design energy converting devices, automobile engines, steam and gas turbines, power plants, compressors, HVAC, alternators, propulsion systems of aircraft and rockets, etc. Thus, every student of Diploma Mechanical Engineering should have a fundamental knowledge of thiscourse. It is a pre-requisite course for many courses of Thermal Engineering in higher semesters.

2. COMPETENCY:

The course should be taught in such a way that it can develop the necessary skills to bridge the gap between theoretical knowledge and its practical application. The students achieve the following competencies after completion of this course:

- **Apply fundamental concepts, laws and principles of thermodynamics on various thermal Devices/systems.**

3. COURSE OUTCOMES (COs)

1. Identify thermodynamic properties and systems by interpreting the basic concepts of thermodynamics.

2. Apply various thermodynamic laws and gas laws to thermal systems.
3. Calculate various parameters of different thermodynamic processes and cycles using P-V and T-s diagrams.

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	0	0	3	30*	70	0	0	100

(*) out of 30 marks under the component of theory CA, 10 marks are allotted for the assessment of the micro-project to facilitate the integration of COs. The remaining 20 marks would be the average of marks of the 2 mid-semester exams to be taken during the semester for assessing the attainment of the cognitive domain. UOs are required for the attainment of the COs.

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

5. UNDERPINNING THEORY

The primary underpinning theory is below based on the higher level UOs of the *Revised Bloom's taxonomy* formulated for developing the COs and competency. If required, more such UOs could be included by the course teacher to focus on attaining COs and competency.

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
Unit–I Basic Concepts of Thermodynamics	1.a Illustrate various terms related to thermodynamics. 1.b Identify thermodynamic properties with appropriate usages. 1.c Describe a zeroth law of thermodynamics.	1.1 Introduction and applications of Engineering thermodynamics. 1.2 Basic thermodynamic Concepts. - State, System, Boundary and Surroundings. - Types of Systems and boundaries with examples. - Thermodynamic properties, their units and classifications. 1.3 Energy, Heat, Work, Power and its simple numericals. 1.4 Thermodynamic equilibrium. 1.5 Thermodynamic Process and Cycle 1.6 Zeroth law of thermodynamics and its application.

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
Unit –II **First Law of Thermodynamics**	2.a Describe the first law of thermodynamics. 2.b Apply the first law of thermodynamics to real-life situations. 2,c Solve various numerical related to the first law of thermodynamics.	2.1 Law of conservation of energy. 2.2 Heat and work relation with Joule's Experiment. 2.3 Statement of the first law of thermodynamics. 2.4 Application of the firstlaw of thermodynamics: - Closed system (Non-flowProcesses). - Open system (Flow Processes). 2.5 Definition of the flow process, control volume and flow work. 2.6 Steady and unsteady flow processes. 2.7 Steady Flow Energy Equations (SFEE) and its applications in Nozzle, Diffuser, Boiler, Turbine, Compressor, Condenser, and throttling devices. 2.8Simple numerical examples based on the above. 2.9 Identify the applications of First law of thermodynamics for green environment.
Unit–III **Second Law of Thermodynamics**	3.a Describe the second law of thermodynamics. 3.b Apply the second law of thermodynamics to real-life situations. 3.c Solve various numerical related thermal efficiency &C.O.P.. 3.d Interpret the entropy, its equations with the unit.	3.1 Limitations of the first law of thermodynamics. 3.2 Concept of heat source, heat sink, heat engine, heat pump, refrigerator and simple numerical on thermal efficiency and COP (Coefficient of Performance) respectively. 3.3 Statement of the second law of thermodynamics: - Kelvin Planck Statement - Clausius Statement 3.4 Applications of the second law of thermodynamics.Also identify its applications for green environment. 3.5 Concept of reversibility and irreversibility. List of irreversibility only. 3.6 Definition of Entropy and its T-ds equation. (Without Derivations) 3.7 Statement of the third law of thermodynamics.
Unit-IV **Ideal Gases and Thermodynamic Processes**	4.a Describe various ideal gas laws. 4.b Derive the relationship of specific heats.	4.1 Concept of Ideal gas. 4.2 Boyle's law, Charle's law and Gay-Lussac law for ideal gases. 4.3 Characteristic gas equation and

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
	4.c Identify various thermodynamic processes. 4.d Calculate the amount of heat transfer, work transfer & internal energy associated with the process. 4.e Plot various thermodynamic processes on P-V and T-S diagrams. 4.f Solve various numerical.	Universal gas constant, Specific heats of gas and their relationship. 4.4 Thermodynamic Processes, its representation on P-V (Pressure-Volume) and T-S (Temperature-Entropy) diagram: - Constant Volume Process - Constant Pressure Process - Constant Temperature Process - Adiabatic Process - Polytropic Process - Throttling Process 4.5 Equations of P-V-T relationship, work transfer, heat transfer and internal energy of the above processes. (Without derivations) 4.6 Simple numerical based on the above.
Unit–V Thermodynamic Cycles	5.a Identify thermodynamic processes in a cycle. 5.b Plot various cycles on P-V and T-s diagram. 5.c Solve various numerical related to power-producing cycles.	5.1 Classifications of thermodynamic cycle. 5.2 Carnot cycle and its representation on P-V and T-s diagram. 5.3 Derivation of thermal efficiency of Carnot cycle and simple numerical based on it. 5.4 Concept of air standard efficiency. 5.5 Otto, Diesel, Dual and Brayton cycle (Without derivation) 5.6 Representation on P-V & T-s diagram, Equation of air standard efficiency (Without derivations) and simple examples. 5.7 Representation of Reversed Carnot cycle and Reversed Brayton cycle on P-V and T-s diagram respectively.

6. SUGGESTED SPECIFICATION TABLE FOR QUESTIONPAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Basic Concepts of Thermodynamics	8	05	04	04	13
II	First Law of Thermodynamics	09	04	05	06	15
III	Second Law of Thermodynamics	05	02	03	03	8

IV	Ideal Gases and Thermodynamic Processes	10	04	06	07	17
V	Thermodynamic Cycles	10	04	06	07	17
	Total	**42**	**19**	**24**	**27**	**70**

Legends: *R=Remember, U=Understand, A=Apply and above (Revised Bloom's taxonomy)*

Note: This specification table gives general guidelines to assist studentsin their learning, and to the teachers, for question paper design and teaching methodology 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 the above table.

7. SUGGESTED STUDENT ACTIVITIES

Sr.No.	Activity.
1.	Identify and list real situations working on a:Zerothlaw of thermodynamics. b:Firstlawofthermodynamics. c:Secondlawofthermodynamics.
2.	Prepare charts of diesel, dual and gasoline cycles.Tabulate the main points of differences between them.
3.	List out the thermodynamic laws/concepts used in the Solar system. Also, Prepare technical specifications of solar rooftop at your home or nearby areas.
4.	Write the specifications of the domesticrefrigeratoravailableatyourhomeandI.C.Engineofanytwo-wheelers.Also,drawandexplainthe cycle on which domestic Refrigerator and I.C. Engine works.
5.	Presentations on "Smart Thermostat" of home appliances.
6.	Collect/ download product catalogs with the specification of various types of air compressors/ I.C.Engines /Refrigerators used in daily life.
7.	Take any thermal Device/system available in the Institute and identify it based on 1)type of system, 2) type of boundary.
8.	Prepare specification of some thermal devices/systems available in the Institute/surrounding.
9.	Give seminars on various topics learned in the course.
10.	Prepare chart on: (1) Types of system, (2) Temperature scale, (3) Types of process, (4) Types of thermodynamic cycles, and (5) Refrigeration cycle, etc.
	Interpret the relationship between different thermodynamic properties.

8. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (IF ANY)

These are sample strategies that the course teacher can use to accelerate the attainment of the various outcomes in this course.

Unit	Unit Title	Strategies
I	Basic Concepts of Thermodynamics	○ Real-life examples. Demonstration ofrealsystems. Movies/Animations. ○ Numericals, Massive Open Online Courses (MOOCs).
II	Ideal Gases and Thermodynamic Processes	
III	First Law of Thermodynamics	
IV	Second Law of Thermodynamics	
V	Thermodynamic Cycles	

9. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to them during the semester. The teacher can assign any activity suggested in section 7 of ***"SUGGESTED STUDENT ACTIVITIES"*** according to their convenience. While designing the micro-project, it should be kept in mind that it encompasses most of the COs.It should be the application of the theoretical knowledge into some practical aspect.

10. SUGGESTED LEARNING RESOURCES

Sr. No.	TitleofBooks	Author	Publication& ISBN
1.	Engineering Thermodynamics	Yunus A. Cengel	Tata McGraw Hill 975-1-25-906256-8
2.	Thermodynamics	R.Yadav	CPH ISBN-13: 9788185444031
3.	Thermodynamics for Engineers	M.L.Mathur	Dhanpatrai & sons 81-200-0029-3
4.	Heat Engines	C.S.Shah& N.C.Pandya	Charotar Publi.House 81-85594-49-X
5.	Elements of Heat Engines Vol.I&II	R.C.Patel	AcharyaBookDepot
6.	Thermodynamics	SAAD	Prentice-Hall
7.	EngineeringThermodynamics-2nd Edition	P.K. Nag	Mc-GrawHillEducation 978-0-07-026062-7
8.	Applied Thermodynamics	R.C.Patel	AcharyaBookDepot
9.	Thermodynamics	Gupta	Pearson 9788131717950

10.	Thermodynamics	J.P. Holman	Tata Mc Graw-Hill
11.	Thermodynamics – Theory & Application	Robert Balmer	Jaico publication house
12.	Fundamentals of Thermodynamics	Sonntag, Borgnakke & Van wylen	John Wiley & sons (ASIA) PVT. LTD

11. SOFTWARE/LEARNING WEBSITES

Sr. No.	Software/Website address	Topic covered
1.	CALPHAD software	Thermodynamic modeling
2.	https://lawofthermodynamicsinfo.com/what-is-thermodynamic-system/	Basic of thermodynamics
3.	https://thermo.pressbooks.com/chapter/chapter-4/	Problems based on first law of thermodynamics
4.	https://study.com/academy/lesson/First-law-of-thermodynamics-law-of-conservation-of-energy.htm	First law of thermodynamics
5.	https://vimeo.com/94762428	First law of thermodynamics
6.	https://www.youtube.com/watch?v=OmhXb-miAhw	Thermodynamic cycles
7.	https://nptel.ac.in/courses/112/105/112105123/	All units
8.	http://www.thermofluids.net/	All units
9.	http://www.grc.nasa.gov/WWW/k-12/airplane/thermo.html	Basic concepts
10.	http://www.youtube.com/watch?v=Xb05CaG7TsQ	First law of thermodynamics

11.	http://www.youtube.com/watch?v=aAfBSJObd6Y	Ca rnot cycle
12.	http://www.youtube.com/watch?v=DHUwFuHuCdw	Secondlaw ofthermodynamics and heat engines
13.	http://www.youtube.com/watch?v=GKqG6n6nAmg	Zeroth law of thermodynamics
14.	https://www.youtube.com/watch?v=ty4F30dRdwk	Understanding entropy
15.	https://www.youtube.com/watch?v=WTtxlaeC9PY	Understanding secondlaw of thermodynamics
16.	https://www.youtube.com/watch?v=Jsnv8L7HdEk	Thermodynamic processes

12. PO-COMPETENCY-CO MAPPING

Semester II	**Engineering Thermodynamics (Course Code: 4321901)**						
	POs						
Competency & Course Outcomes	**PO1** (Basic & Discipline specific knowledge)	**PO2** (Problem Analysis)	**PO3**(Design/ development of solutions)	**PO4**(Engineering Tools, Experimentation Testing)	**PO5** (Engineering practices for society, sustainability & environment	**PO6** (Project Management)	**PO7** (Life-long learning)
Competency	Apply fundamental concepts, laws and principles of Thermodynamics on various thermal devices/systems.						
CO.1 Identify thermodynamic properties and systems by interpreting the basic concepts of thermodynamics.	3	-	-	-	-	-	2
CO.2 Apply various thermodynamic	3	2	-	-	1	-	2

laws and gas laws to thermal systems.							
CO.3 Calculate various parameters of different thermodynamic processes and cycles using P-V and T-s diagrams	3	2	1	-	-	-	-

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

13. COURSE CURRICULUM DEVELOPMENT COMMITTEE

o **GTU Resource Persons:**

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