



GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering

Level: UG

Branch: Chemical Engineering

Subject Code: BE05005061

Subject Name: Fuels and Combustion

W. E. F. Academic Year:	2024-25
Semester:	5
Category of the Course:	Professional Elective Course - 2

Prerequisite:	Material and Energy Balance Calculations
Rationale:	The fuel and combustion course introduces the fundamental concepts of solid, liquid, and gaseous fuels, including their origin, classification, preparation methods, and characterization based on physico-chemical properties. Coal, as the primary solid fossil fuel, is covered in detail with respect to its mining, cleaning, and combustion processes. Petroleum, the major liquid fuel, is discussed in terms of exploration, evaluation, distillation, and secondary processing. Important gaseous fuels are also included. Different important gaseous fuels are also included. The course covers the fundamentals of combustion along with combustion appliances, with emphasis on the thermodynamic aspects of fuel combustion. Combustion technology is addressed through the study of various combustion systems and appliances. Basic knowledge of advanced topics such as continuous industrial furnaces and oxy-rich combustion is also incorporated to provide broader exposure and highlight the practical importance of the subject.

Course Outcome:

After completion of the course, student will able to:

No	Course Outcomes
01	Understand the history, generation, and importance of solid liquid and gaseous fuels
02	Explain coal combustion and processing technologies to evaluate and ensure efficient utilization of solid fuels.
03	Understand petroleum origin, refining, properties, products, and storage for efficient and safe use of liquid fuels.
04	Understand the types, production, properties, handling, and applications of manufactured and bio-fuels for sustainable energy use.
05	Apply combustion stoichiometry and thermodynamics to analyze and optimize fuel combustion and furnace systems for efficient energy use.

Teaching and Examination Scheme:

Teaching/Learning Scheme in hrs/semester					Total Credits	Assessment Pattern and Marks					Total Marks
L	T	P	PBL*	TH	TH/30	Theory		Practical			
						ESE (E)	PA (M)	PA (I)	PBL(I)	ESE (V)	
45	15	0	30	90	3	70	30	00	30	50	180



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Where L = Lecture, T= Tutorial, P= Practical, TW/SL = Term-Work / Self-Learning, TH = Total Hours, ESE = End-Semester Examination, PA = Progressive Assessment

* **Problem Based Learning (PBL) aims to accommodate learning beyond syllabus as per clause 9.4 of NBA manual.**

Course Content:

Unit No.	Content	No.of Hours	%of Weightage
1.	Introduction: Fuel: Definition and its Types, History and production of solid, liquid and gaseous fuels, present scenario and consumption pattern of fuels, definitions of fundamental properties of fuels and their measurements techniques	07	15
2.	Solid fuels: Coal origin, its classification, composition, and properties. Coal mining, preparation, and washing. Combustion of coal and coke making, different types of coal combustion techniques, coal tar distillation, coal liquefaction: direct and indirect liquefaction, coal gasification, oxidation and hydrogenation. Efficient use of solid fuels.	07	20
3.	Liquid Fuels: Origin and classification of petroleum, refining, properties & testing of petroleum products, petroleum refining in India, liquid fuels from other sources, storage and handling of liquid fuels.	07	15
4.	Gaseous Fuels: Origin and classification of gaseous fuels: Synthesis of natural gas, producer gas, water gas, biogas, LPG, refinery gas, hydrogen, acetylene other fuel gases. Cleaning, purification and quality enhancement of gaseous fuels and their applications.	05	10
5.	Synthetic fuels: Agro fuels and its properties related to combustion, handling, and storage and application. Bio-Fuels: types of bio-fuels, production processes and technologies and its applications.	05	10
6.	Stoichiometry of combustion: Estimation of minimum amount of air required for a fuel of known composition, theoretical and actual combustion processes - Air fuel ratio, estimation of dry flue gases for known fuel composition, calculation of the composition of fuel and excess air supplied from exhaust gas analysis, dew point of products. Calorific value of fuels, adiabatic flame temperature, mechanism and kinetics of combustion, oxy-rich combustion.	07	15
7.	Combustion Technology: Stoichiometry and thermodynamics of combustion, calculation of heat of formation and heat of combustion, first law analysis of combustion of oil, combustion of coal, combustion of gas, flue gas analysis, flame properties, draft system, combustion appliances such as gas burners and its functional requirement, gas burner classification, stoker firing, pulverized system of firing, fluidized bed combustion process and its controls. Introduction to different types of furnaces: heat treatment furnaces, industrial furnaces, process furnaces, and kilns. Applications of batch and continuous furnaces.	07	15
	Total	45	100



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Overall Course SDG Mapping:

This course aligns with SDG 7: Affordable and Clean Energy, SDG 9: Industry, Innovation and Infrastructure, SDG 12: Responsible Consumption and Production, and SDG 13: Climate Action, by promoting efficient fuel utilization, cleaner combustion technologies, and sustainable energy practices.

Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
15	20	25	5	5	---

Where R: Remember; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create (as per Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

References/Suggested Learning Resources:

(a) Books:

1. Irvin Glassman, "Combustion" 2nd ed., Academic Press.
2. John Griswold, "Fuels Combustion and Furnaces" Mc-Graw Hill Book Company Inc.
3. S.P. Sharma & Chander Mohan, "Fuels & Combustion", Tata McGraw Hill Publishing Co. Ltd.
4. Gupta O.P, "Elements of Fuels, Furnaces & Refractories", 3rd ed., Khanna Publishers.
4. Dr. Samir Sarkar, "Fuels & Combustion", 2nd ed., Orient Longman.
5. B. I Bhatt & S. B. Thakore, "Stoichiometry", 5th ed., Tata McGraw Hill Publishing Co. Ltd.
6. James G, "Chemistry and Technology of Petroleum", Marcel Dekker, NY
7. B. K. Sharma, "Fuels and Petroleum Processing", 1st ed., Goel publishing, Meerut.
8. Blokh A.G, "Heat Transmission in Steam Boiler furnaces", Hemisphere Publishing Corpn.

(b) Open source software and website:

1. Students can refer to video lectures available on the websites including NPTEL
2. Students can refer website of FurnXpert "https://www.furnxpert.com/casestudy" for case studies of furnace simulation and analysis.

List of suggested activities for Problem based Learning:

Sl. No.	Activity	No. of hours	Total hours claimed	Evaluation criteria
1	Assignments on fuel and combustion topics	Five assignments (2h each)	15	Quality of submitted assignments.



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2	Literature Review: Review 3–5 research papers on solid/liquid and gaseous fuels or related topics and prepare a report.	Literature review: 5h Report preparation: 5h	10	Relevance of papers, depth of research papers reviewed, technical analysis, Quality of report.
3	Online Course (MOOC/NPTEL/SWAYAM/edX, etc.) on Fluid Flow Operations in chemical engineering	Minimum course duration of 15 hours	15	Assessment through an examination at the end of the course.
4	Developing posters, charts or PowerPoint presentations on topics related to any fuels.	Study and in-depth analysis of content: 4h Preparation and presentation of visual content: 1h	5	Quality of topic researched and presentation.
5	Technical video based learning related to subject and report preparation.	Duration of video: 4h, report preparation: 1h.	5	Quality of technical video based learning and report prepared.
6	Development of physical model	Model development: working 10h, non-working 5h	10	Quality of model developed and explanation.
7	Industry visit	Industry visit: 5h, Report preparation: 5h	10	Quality of observations made and detail report submitted.
8	Case study	Data collection, case analysis: 5h Report preparation: 5h	10	Understanding and analysis of the selected case and report submitted.

- Above activities are suggestive, faculty can choose any of these activities.
- The number of hour is suggestive. Faculty can sub-divide the number of hours based on the activity. However, the total number of hours is fixed.
- All records pertaining to the evaluation and assessment of self-learning activities must be properly maintained and preserved at the institute level. These records should be made available to the university upon request.
- Institutes are encouraged to utilize digital platforms, such as Microsoft Teams, for effective record keeping and to ensure transparency in the evaluation and assessment of problem based learning.

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