GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Master of Engineering

Level: PG

Subject Code : ME02000551

Subject Name : Combustion Engineering

w. e. f. Academic Year:	2024-25
Semester:	2
Category of the Course:	Professional Elective Course

Prerequisite:	Nil
Rationale:	The course is designed to provide fundamental knowledge of combustion of various fuels.

Course Outcome:

After Completion of the Course, Student will able to:

No	Course Outcomes	RBT level
1	Discuss concepts of the thermo-chemistry of combustion to evaluate the quality of combustion in energy systems, including thermal engines.	Evaluate
2	Appraise laminar and turbulent premixed and non-premixed flames.	Evaluate
3	Model droplet evaporation and burning and explain their applications.	Apply
4	Analyze combustion of solid fuels.	Analyze

Teaching and Examination Scheme:

Teaching Scheme (in Hours)			Total Credits L+T+ (PR/2)	Assessment Pattern and Marks				Total Marks
				Theory		Tutorial / Practical		
L	T	PR	C	ESE (E)	PA / CA (M)	PA/CA (I)	ESE (V)	
3	0	2	4	70	30	20	30	150

Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1.	**Introduction to Combustion and Thermochemistry:** Review of property relations, reactant and product mixtures, adiabatic flame temperatures, chemical equilibrium, equilibrium products of combustion, rudiments of mass transfer, liquid – vapor interface boundary conditions, droplet evaporation	06	12
2.	**Chemical Kinetics and Mechanisms:** Global versus elementary reactions, elementary reaction rates, rates of reaction for multi – step	06	12

	mechanisms, the $H_2 – O_2$ system, carbon monoxide oxidation, oxidation of higher paraffins, methane combustion, oxides of nitrogen formation		
3.	**Coupling Chemical and Thermal Analysis of Reacting Systems:** Constant pressure and constant volume fixed mass reactor, well stirred reactor, plug flow reactor, applications to combustion system modeling **Simplified Conservation Equations for Reacting Flows:** Mass conservation (continuity), momentum conservation, energy conservation, the concept of a conserved scalar	08	18
4.	**Laminar Premixed Flames:** Physical description, simplified analysis, factors influencing flame velocity and thickness, flame speed correlations for selected fuels, quenching, flammability and ignition, flame stabilization **Laminar Diffusion Flames – Burning Jets:** Non reacting constant – density laminar jet, jet flame physical description, simplified theoretical descriptions, flame lengths for circular – port and slot burners, soot formation and destruction	09	20
5.	**Droplet Evaporation and Burning:** Simple model of droplet evaporation and droplet burning, one dimensional vaporization – controlled combustion, some applications of droplet evaporation and droplet burning	04	10
6.	**Turbulent Premixed and Non premixed Flames:** Definition of turbulence, length scales in turbulent flows, analyzing turbulent flows, axisymmetric turbulent jet, definition of turbulent flame speed, structure of turbulent premixed flames, wrinkled laminar flame regime, distributed reaction regime, flamelets in eddies regime, flame stabilization, jet flames, applications of turbulent premixed flames	09	20
7.	**Burning of Solids:** Coal fired boilers, heterogeneous reactions, burning of carbon, coal combustion	03	08
	Total	**45**	**100**

Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
-	**20**	**30**	**20**	**30**	**-**

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

References/Suggested Learning Resources:

(a) Books:

1. An Introduction to Combustion – Concept and Applications, Stephen R Turns, McGraw-Hill

2. Principles of Combustion, Kenneth K. Kuo, John Wiley & Sons
3. Fundamentals Of Combustion, D P Mishra, PHI Learning
4. Combustion: Physical and Chemical Fundamentals, Modeling and Simulation, Experiments, Pollutant Formation, Warnatz, J., Maas, Ulrich, Dibble, Robert W., Springer
5. Understanding Combustion, H S Mukunda, Universities Press
6. Flame and Combustion by J. A. Barnard and J. N. Bradley, Chapman and Hall

(b) Open-source software and website:

1. https://onlinecourses.nptel.ac.in/noc23_me27/preview
2. https://archive.nptel.ac.in/courses/103/105/103105110/

Suggested Course Practical List:

1. To estimate the fuel composition from the analysis of exhaust gases.
2. To find the calorific value of the given fuel.
3. To find the effect of temperature on various flow properties of liquid fuel.
4. To calculate the amount of heat release by combustion of solid fuel at different surrounding conditions.
5. To observe the effect of various parameters on the flame structure.
6. To measure the change of operating parameters on the spray of liquid fuel.
7. To understand the process of droplet evaporation and burning under various condition.
8. To study about chemical and thermal analysis of reacting systems.
9. To observe the effect of turbulence on the flames.
10. To analyses the effect of various operating parameters on the flame stabilization.

List of Laboratory/Learning Resources Required: 4 stroke petrol/diesel engine test set, flame propagation and stability measurement unit, flue gas analyzer (5 gas analyzer suggested), different types of calorimeters, engine cycle analyzer

Suggested Project List:

Suggested Activities for Students: Students are required to download 3-5 research papers from reputed international journals on the recent advancement in the areas of combustion. They need to go through the same and prepare a review for the research papers. The review should have three parts: Summary, Critical Evaluation and Creative synthesize

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