



GUJARAT TECHNOLOGICAL UNIVERSITY

Master of Engineering
Subject Code: 3722114
Semester – II
Combustion Engineering

Type of course: Program Elective

Prerequisite: Nil

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

Teaching and Examination Scheme:

Teaching Scheme			Credits C	Examination Marks				Total Marks
L	T	P		Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
3	0	2	4	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs
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	6
2	Chemical Kinetics and Mechanisms: Global versus Elementary Reactions, Elementary Reaction Rates, Rates of Reaction for Multi – step Mechanisms, The H ₂ – O ₂ System, Carbon Monoxide Oxidation, Oxidation of Higher Paraffins, Methane Combustion, Oxides of Nitrogen Formation	6
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	4
4	Simplified Conservation Equations for Reacting Flows: Mass Conservation (Continuity), Momentum Conservation, Energy Conservation, The Concept of a Conserved Scalar	3
5	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	8
6	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	4
7	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	8



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8	Burning of Solids: Coal Fired Boilers, Heterogeneous Reactions, Burning of Carbon, Coal Combustion	3
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Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
10	20	20	20	20	10

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (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.

Reference 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 (English) 2nd Edition, H S Mukunda, Universities Press
6. Flame and Combustion by J A Barnard and J N Bradley, Chapman and Hall.

Course Outcomes:

Sr. No.	CO statement	Marks % weightage
CO-1	Discuss concepts of the thermo-chemistry of combustion to evaluate the quality of combustion in energy systems, including thermal engines.	44
CO-2	Appraise laminar and turbulent premixed and non-premixed flames.	38
CO-3	Model droplet evaporation and burning and explain their applications.	10
CO-4	Analyze combustion of solid fuels.	08

List of Experiments:

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.

Major Equipment: 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

List of Open Source Software/learning website: <http://nptel.ac.in/courses/101104014/1>