



GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering

Subject Code: 3171924

Semester – VII

Subject Name: Principles of Combustion

Type of course: Professional Elective

Prerequisite: Zeal to learn the subject

Rationale: Applications of combustion exist in many field of Mechanical Engineering and therefore basic course on combustion may be helpful to the interested ones.

Teaching and Examination Scheme:

Teaching Scheme			Credits	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	Combustion and Thermochemistry: Introduction, Heat of reaction and formation, Free energy and the equilibrium constants, Flame temperature calculations – Analysis & Practical considerations, Sub and supersonic combustion thermodynamics – Comparisons & Stagnation pressure considerations	4
2	Chemical Kinetics: Introduction, Rates of reactions and their temperature dependence - The Arrhenius rate expression & Transition state and recombination rate theories, Simultaneous interdependent reactions, Chain reactions, Pseudo-first-order reactions and the “fall-off” range, The partial equilibrium assumption, Pressure effect in fractional conversion, Chemical kinetics of large reaction mechanisms – Sensitivity analysis, Rate of production analysis, Coupled thermal and chemical reacting systems & Mechanism simplification	10
3	Chemical and Thermal Systems: Constant pressure fixed mass reactor, constant volume reactor, well stirred reactor, plug flow reactor, application to combustion system modelling	6
4	Conservative Equations: Mass conservation, Species mass conservation, Multi component diffusion, momentum conservation, Energy conservation, Conserved Scalar Concept	6
5	Laminar Flames: Laminar Premixed Flames - Physical Description, Simplified Analysis, Detailed analysis Factors influencing flame velocity and thickness, flame stabilization, ignition Laminar Diffusion Flames – non reacting constant density laminar jet, jet flame, flame lengths, soot formation and destruction, counter flow flames	10
6	Turbulent Flames: Applications of turbulent flames, Definition of turbulent flame speed, structure of turbulent premixed flames, wrinkled flame regime, flamelets, flame stabilization, Jet Flames	9



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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
20	20	40	20	-	-

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, Concepts and Applications, Stephen R. Turns, McGraw-Hill Education
2. Combustion, Irvin Glassman, Academic Press
3. Combustion Theory, Forman A Williams, Addison-Wesley
4. Combustion Physics, C.K. Law, Cambridge University Press
5. Combustion, Flames and Explosions of Gases, Bernard Lewis and Guenther von Elbe, Academic Press
6. Chemical Kinetics, Keith Laidler, Harper and Row

Course Outcomes:

Sr. No.	CO statement	Marks % weightage
CO-1	To comprehend combustion, types of flames and effect and control of combustion	10
CO-2	To apply the theories of chemical equilibrium	23
CO-3	To mass, momentum and energy conservation to combustion process and make calculations of various reactors	24
CO-4	To apply concepts of laminar premixed and diffusion flames to appropriate reactive systems	23
CO-5	To apply concepts of turbulent flames to appropriate reactive systems	20

List of Experiments:

1. Find the smoke point of different fuels.
2. Find the pour point and cloud point of various lubricants.
3. Test the performance of fuel pump with fuel pump test rig.
4. Study of various spray characteristics of fuel.
5. Study of flame stabilization at different equivalence ratio.
6. Study of laminar premixed flames.
7. Study of turbulent flames.
8. Model different H_2/O_2 mechanism and find equilibrium temperatures at different equivalence ratios.

Major Equipment: Fuel pump test rig, Bunsen Burner, Temperature measurement apparatus, Fuel supply system, Ignition system

List of Open Source Software/learning website: <https://nptel.ac.in/course.php>