GUJARAT TECHNOLOGICAL UNIVERSITY

MECHANICAL (THERMAL ENGINEERING) (21)
COMBUSTION ENGINEERING
SUBJECT CODE: 2732104
M.E. 3rd SEMESTER

Type of course: Major Elective

Prerequisite: Nil

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

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks						Total Marks
				Theory Marks		Practical Marks				
L	T	P	C	ESE (E)	PA (M)	ESE (V)		PA (I)		
						ESE	OEP	PA	RP	
3	2#	2	5	70	30	20	10	10	10	150

Content:

Sr No	Content	Total Hrs	% 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	6	15
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	15
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	9
4	**Simplified Conservation Equations for Reacting Flows:** Mass Conservation (Continuity), Momentum Conservation, Energy Conservation, The Concept of a Conserved Scalar	3	7
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	4	9
6	**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	4	9
7	**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	9
8	**Introduction to Turbulent Flows:** Definition of Turbulence, Length Scales in Turbulent flows, Analyzing Turbulent Flows, Axisymmetric Turbulent Jet	3	7

9	**Turbulent Premixed and Non premixed Flames:** 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	5	13
10	**Burning of Solids:** Coal Fired Boilers, Heterogeneous Reactions, Burning of Carbon, Coal Combustion	3	7

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 Outcome:

After learning the course the students should be able to:

1. Understand the process of combustion of solid, liquid and gaseous fuels.
2. Understand the kinetics and mechanisms of combustion

List of Experiments:

1. To study about the thermochemistry of combustion.
2. To understand the process of chemical kinetics.
3. To study about chemical and thermal analysis of reacting systems.
4. To study conservation equations for reacting flows.
5. To understand laminar premixed flames.
6. To study about laminar diffusion flames and burning jets.
7. To understand the process of droplet evaporation and burning.
8. To study about turbulent flows in flames.
9. To study turbulent premixed and non-premixed flames.
10. To study about the burning of solid fuels.

Design based Problems (DP)/Open Ended Problem:

1. Calorimetry: Bomb Calorimeter Experiment
2. Determine which nut contains the most energy? Almonds, peanuts or cashews? Why?
3. Time step study of combustion in di diesel engine

List of Open Source Software/learning website:

- http://nptel.ac.in/courses/101104014/1

Review Presentation (RP): The concerned faculty member shall provide the list of peer reviewed Journals and Tier-I and Tier-II Conferences relating to the subject (or relating to the area of thesis for seminar) to the students in the beginning of the semester. The same list will be uploaded on GTU website during the first two weeks of the start of the semester. Every student or a group of students shall critically study 2 papers, integrate the details and make presentation in the last two weeks of the semester. The GTU marks entry portal will allow entry of marks only after uploading of the best 3 presentations. A unique id number will be generated only after uploading the presentations. Thereafter the entry of marks will be allowed. The best 3 presentations of each college will be uploaded on GTU website.