GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3173915
Semester – VII
Subject Name: NANOCATALYSTS

Type of course: Material Technology

Prerequisite: Synthesis of Nanomaterial

Rationale: Catalysis uses in high impact areas such as improved chemical process efficiency, environmental remediation and development of energy. So this course will provide fundamental understanding of catalytic kinetics and study of various type nanocatalysts.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
L	T	P	C	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, Concept and Catalyst Characterization Rate of reaction Elementary step and rate determining step (RDS) Reaction pathway Reaction rate in reactors BET theory, total surface area Pore volume and pore size distribution Hg porosimetry method N2 desorption method Overall pore size distribution	8
2	Adsorption and Desorption Processes	8

	Adsorption Rate Desorption Rate Adsorption equilibrium on uniform surfaces-Langmuir isotherms single-site (non-dissociative) adsorption Dual-site (dissociative) adsorption Derivation of the Langmuir isotherm Adsorption equilibrium on non-uniform surfaces-Langmuir isotherms The Freundlich isotherm The Temkin Isotherm Activated adsorption	
3	Kinetics and Mechanisms Transition-state theory (TST) the steady-state approximation (SSA) Heats of adsorption – atomic Heats of adsorption – molecular Activation barriers – dissociation Activation barriers – recombination Reaction Model with a RDS - unimolecular and bimolecular Langmuir-Hinshelwood mechanism Eley-Rideal mechanism; Sabatier activity	**8**
4	Catalyst in Nanoscale Noble metals nanocatalyst (Ru, Rh, Pd, Pt, etc) Polymer stabilized Rh and Ru nanoparticles Oxide supports for nano-catalysts; Carbon supports for nanocatalysts	**9**

	Gold nanoparticle-based catalyst Gold vs. Palladium catalysts for the aerobic oxidation of alcohols Oxide based catalyst Metal free catalyst (CNT, Graphene, h-BN etc. based Catalyst) Transition metal dichalcogenides based catalyst	
5	Application of Nano-Catalyst Toxic Gases conversion using nanocatalyst: NOx CO oxidation using nanocatalyst Hydrogenation of compounds with C≡C bonds, hydrogenation of aromatic compounds Green house gases: CO2 conversion Dissociative mechanism: oxygen reduction reaction using nanocatalyst Associative mechanism: oxygen reduction reaction using nanocatalyst Hydrogen Production using oxide and dichalcogenides based catalyst Photocatalytic reaction using nanocatalyst	**9**

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
30	**30**	**30**	**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. M. Albert Vannice, "Kinetics of Catalytic Reactions", Springer, 2008

2. Kurt W. Kolasinaski, "Surface Science: Foundations of Catalysis and Nanoscience Second Edition", 2 nd Edition, John Wiley & Sons, England, 2005 Reference Books/Other Reading Material

3. Edited by Ryan Richards, "Surface and Nanomolecular Catalysis", Taylor & Francis, FL 33487-2742, 2006 4. Edited by Didier Astruc "Nanoparticles and Catalysis", WILEY-VCH, Weinheim, 2008

Course Outcomes:

Sr. No.	CO statement	Marks % weightage
CO-1	Explain reaction kinetics and adsorption and desorption processes	25 %
CO-2	Explain the different type of reaction mechanism	25 %
CO-3	Describe the most important industrial catalytic processes and catalysts	25 %
CO-4	Describe catalytic processes at nano-levels	25 %