

Subject Code: 1RI3000102	Subject Title: Essentials of Disciplinary Research Subject-1 Subject Sub-Title: Surface Catalysis
Pre-requisite Subject	

Objectives of course: Developing Strong Research Background for effective research during Ph.D

Learning outcomes: Scholars will be updated with current research field.

Teaching Scheme (Credit Distribution)				Assessment Scheme (Weightage)	
Lecture	Tutorial	Practical	Credit	Hall Exam	Continuous Evaluation
4	--	--	4	60%	40%

Continuous evaluation is based on number of assignments/tutorials/presentations/laboratory practicals/small projects as per the instruction by the concerned supervisors.

Unit	Content	Lecture	Wt. (%)
1	Surface Science and Catalysis: Kinetics of Gas-solid reaction; LH and LR Mechanism, Adsorption and adsorption isotherm; Physisorption and Chemisorption of gas molecules to the solid surface; determination of particle size from chemisorptions measurement, TPR/TPD/TPO techniques; elementary gas phase reaction, spillover effect, multiplet theory brief overview of catalytic reactor, fixed bed and batch reactor, mass transfer and heat transfer on the catalyst surface; promotional and poisoning effect on catalyst surface; selected organic reaction.	10	40%
2	Solid State Chemistry Crystal structure of solids: Fundamental of lattices, unit cell, atomic coordinates, Bravais lattices, symmetry elements in crystals, crystal direction and planes, reciprocal lattices, packing efficiency, radius ratios; structure and types of solid. Crystal diffraction by X-rays, Structure factor, Neutrons and Electrons; Structure determination by X-ray diffraction, Semiconductors (intrinsic & extrinsic), and Devices, Electronic properties and Band theory of solids. Fermi level; Imperfections in Solids: Point, Line, Surface; Thermodynamics of the Defects; Ionic Conductivity & Photoconductivity; Colour Centers, Traps, Phosphors.	6	30%
3	Green Chemistry Introduction, Principles & Concepts of Green Chemistry. Green starting materials, Green reagents, Green solvents and reaction conditions Green catalysis Green synthesis- Real world cases (Traditional processes and green ones), Catalysis and Green Chemistry: Oxidations and Reductions, C-C Bond Formation,	6	30%

List of References:

1. The Surface Science of Metal Oxides, Victor E. Henrich, P. A. Cox, Cambridge University Press; New Ed edition, 1996.
2. Current Trends of Surface Science and Catalysis, Jeong Young (Ed.) Park (Author), Jeong Young Park (editor), 1st Edition, Springer, 2013.
3. Green Chemistry: Theory and Practice, Anastas, P. T.; Warner, J. C. Oxford University Press: New York, 1998.
4. Renewables-Based Technology: Sustainability Assessment; Dewulf, J.; Langenhove, H. V., Eds.; John Wiley & Sons, Ltd, 2006.
5. Solid State Chemistry and its applications, A. R. West, Wiley, 1st Edition, 2001.
6. Solid State Chemistry – An Introduction, L. Smart and E. Moore, Taylor & Francis Group, 4th Edition, 2012

Subject Code: 1RI3000103	Subject Title: Essentials of Disciplinary Research Subject-2 Subject Sub-Title: Instrumentation Techniques
Pre-requisite Subject	

Objectives of course: Developing sound knowledge of Characterization and Analysis for research.

Learning outcomes: Scholars can analyze the data by their effective course knowledge.

Teaching Scheme (Credit Distribution)				Assessment Scheme (Weightage)	
Lecture	Tutorial	Practical	Credit	Hall Exam	Continuous Evaluation
4	--	--	4	60%	40%

Continuous evaluation is based on number of assignments/tutorials/presentations/laboratory practicals /small projects as per the instructions by the concerned supervisors.

Unit	Content	Lecture	Wt. (%)
1	Microscopic Techniques Principle, Instrumentation and applications of microscopic techniques like Scanning electron microscopy (SEM) and Transmission electron microscopy (TEM), Scanning tunneling microscopy (STM), Atomic force microscopy (AFM), Electron probe microscopy (EPM).	6	25%
2	Molecular Spectroscopy Principle, Instrumentation and applications of Electron Energy Loss Spectroscopy (EELS), Auger Electron Spectroscopy (AES), Infra-red spectroscopy (IR), Inductively coupled plasma spectrometry (ICP), UV-Vis spectroscopy, Si- nuclear magnetic resonance spectroscopy (S-NMR), Al- nuclear magnetic resonance spectroscopy (Al-NMR), Electron Spin resonance spectroscopy (ESR)	6	25%
3	Diffraction and Scattering Principle, Instrumentation and applications of X-ray diffraction techniques (XRD) and X-ray scattering techniques, Electron diffraction and scattering techniques, Neutron diffraction and scattering techniques.	6	25%
4	Chromatography Techniques Principle, theory, instrumentation and applications of Gas Chromatography (GC), high performance liquid chromatography (HPLC), Ultra high performance liquid chromatography (UHPLC), liquid Chromatography –nuclear magnetic resonance (LC-NMR), liquid chromatography-mass spectrometry (LC-MS), supercritical fluid chromatography	6	25%

	(SFC), Flash chromatography, Counter Current Chromatography, Ito-Coil-Planet Centrifugal Extractor(ICE),		
--	--	--	--

List of References:

1. Fundamentals of Molecular Spectroscopy, C. N. Banwell and E. M. McCash, 4th Edition, Tata McGraw-Hill Education, 1994.
2. Molecular Quantum Mechanics, P. W. Atkins and Ronald S. Friedman, 4th Edition, Oxford University Press, 2010.
3. Spectra of Atoms and Molecules, P. F. Bernath, 2nd Edition, Oxford University Press, 2005.
4. Electron Energy-Loss Spectroscopy in the Electron Microscope, R. F. Egerton, 3rd Edition, Springer, 2011.
5. Scanning Probe Microscopy and Spectroscopy, R. Wiesendanger, Cambridge University Press, 1994.
6. Materials Characterization, Introduction to Microscopic and Spectroscopic Methods, Y Leng, 2nd Edition, Wiley, 2008.
7. Introduction to macromolecular crystallography, Alexander McPhearson, Wiley-Liss, 2003.
8. Crystals and crystal structures, Richard Tilley, John Wiley & Sons, 2006
9. "Analytical Chemistry" by Gary D. Christian, 6th Edition, John Wiley and Sons Inc. New Jersey.
10. Beginners Guides to UPLC: Ultra-Performance Liquid Chromatography By Douglas R. McCabe, Eric S. Grumbach & Joseph C. Arsenault.
11. LC/MS: A practical Users' Guide by Marvin C. McMaster.
12. LC-NMR and other Hyphenated NMR Technique overview and application
13. Supercritical Fluid Chromatography by Colin F. Poole
14. Fundamentals of analytical chemistry, Douglas Skoog, Donald West, F. Holler, Stanley Crouch, 9th Edition, Cengage Learning, 2013
15. Materials Characterization, Introduction to Microscopic and Spectroscopic Methods, Y Leng, 2nd Edition, Wiley, 2008.