

Course Type	Course Code	Name of Course	L	T	P	Credit
DE	NCHD503	Catalysts and Materials Characterization Techniques	3	0	0	3

### Course Objective

To provide knowledge on basic and advanced characterization techniques for catalysts and other materials used in chemical processes.

### Learning Outcomes

Students will have essential knowledge of characterization techniques for catalysts and other materials.

Unit No.	Description of Lectures	Lecture Hrs.	Learning Outcomes
1.	<b>Physisorption technique:</b> Surface area and pore analysis using different techniques like BET, BJH, mercury porosimetry, etc.	7	Students will understand the surface and textural properties of catalysts and materials including surface area and pore size etc.
2.	<b>Chemisorption technique:</b> Determination of metal dispersion on catalyst surface and metal area using hydrogen and carbon monoxide chemisorption studies. Temperature programmed reduction (TPR) for rate of reduction of active metals, Effect of temperature and correlations with catalyst activity.	7	Students will understand metal dispersion in a catalyst, measuring reduction temperature and active metal loading etc.
3.	<b>Thermal Analysis:</b> Rate of desorption using temperature-programmed desorption (TPD) for adsorbed molecules as a function of temperature and acid–base properties of catalysts. Use of thermo gravimetric analysis (TGA) in the analysis of thermal-mass-loss and energy analysis	7	Students will understand analysis of acidity and basicity in a catalyst, materials thermal stability etc.
4.	<b>Spectroscopic techniques:</b> UV-vis, Infra-red and Raman spectroscopy for concentration measurement, interaction of metal oxides, band gap, etc, identification of compounds and oxidation state.	7	Students will understand the methods of analysis for functional groups in a catalyst, band gap and concentration etc.
5.	<b>Structural analysis:</b> X-ray diffraction (XRD) for characterization of bulk crystal structure and chemical phase composition, X-ray photoelectron spectroscopy (XPS) for surface characterization	7	Students will learn the analysis of different hkl planes, crystallinity and crystallite size in a catalyst, interaction of metal and support etc.
6.	<b>Microscopic techniques:</b> Scanning electron microscopy (SEM) for imaging topography of solid surface Transmission electron microscopy (TEM) for determination of the micro-texture and microstructure	7	Students will learn morphological and compositional analysis of catalysts and materials.

	<b>Total</b>	<b>42</b>	
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**Textbooks:**

1. Kaufmann (Ed), E.N. (2003). *Characterization of Materials*, Wiley –Inter Science.

**Reference Books:**

1. Carberry, J.J. (2001). *Chemical and catalytic reaction Engineering*, Dover Publications.
2. Leng, Y. (2008). *Materials Characterization: Introduction to microscopic and spectroscopic methods*. Wiley.
3. Ertl, G. Knozinger, H. and Weitkamp, J. (1997). *Handbook of Heterogeneous Catalysis*, Vol. 2, Wiley VCH.
4. Banwell, Colin N. & McCash, Elaine M. (2000). *Fundamentals of Molecular Spectroscopy*. Tata McGraw-Hill Pub. Co.