

**ACADEMIC AFFAIRS OFFICE
INDIAN INSTITUTE OF TECHNOLOGY ROORKEE**

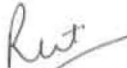
No. Acd./2035/IAPC-78

Dated: January 21, 2020

Head, Department of Chemistry
(through e-mail)

The IAPC in its 78th meeting held on 31.12.2019 vide **Item No. 78.2.3** considered and accepted the proposal of Department of Chemistry to introduce the following Pre-Ph.D. courses (**Appendix-A**):

- 1. CYN-702: Chemistry of Materials**
- 2. CYN-703: Advanced Material Characterization Techniques**


Assistant Registrar (Curriculum)

Encl: as above

Copy to (through e mail):-

1. All faculty
2. All Heads of Departments/ Centres
3. Dean, Academic Affairs
4. Associate Dean of Academic Affairs (Curriculum)
5. Channel I/ Academic webpage of iitr.ac.in

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: Department of Chemistry

1. Subject Code: CYN-702

Course Title: Chemistry of Materials

2. Contact Hours: L: 3

T: 0

P: 0

3. Examination Duration (Hrs.):

Theory: 3

Practical: 0

4 Relative Weightage: CWS: 20-35 PRS: 0 MTE: 20-30 ETE: 40-50 PRE: 0

5. Credits: 3

6. Semester: Autumn/Spring

7. Subject Area: PEC

8. Pre-requisite: Basic chemistry knowledge

9. Objective: To provide knowledge on materials chemistry, synthesis, characterization, properties and applications of materials

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Introduction to chemistry of materials. Historical perspective, classification schemes, approaches to produce new materials, role of chemistry in material science and applications, role of bonding, structure and composition, powders, thin films, monoliths, porous materials, amorphous materials, nanomaterials.	4
2.	Types of materials. Metals and alloys; Semiconductors; Ceramics-conventional and modern ceramics; Polymers and composites-types, biopolymers and inorganic polymers; Metamaterials; Carbon-based materials-carbon nanotubes, fullerenes, graphene and other carbon nanomaterials.	10
3.	Synthesis of materials. Conventional synthetic methods: colloidal synthesis, precipitation and co-precipitation, hot injection, sol-gel synthesis, ceramic method, mechanical attrition. Non-conventional synthetic methods: hydrothermal and solvothermal, electrochemical reduction, sonochemistry, microwave-assisted synthesis, and biomineralization; Soft-chemistry methods: ion-exchange, intercalation and exfoliation; Thin film growth: dip coating, spin-coating, chemical vapor deposition, chemical vapor transport, atomic layer deposition and pulsed laser deposition method	14
4.	Properties and applications. Structural, optical, superconducting, thermoelectric and magnetic materials; dielectrics; energy materials - supercapacitors, batteries, fuel cells, solar cells, hydrogen storage and nuclear materials; materials for healthcare; materials for environmental remediation - control of greenhouse gas emission, sequestration and utilization, water treatment.	14
Total		42

11. Suggested Books:

Sl. No.	Authors/ Title/ Publisher	Year of Publication
1.	“Introduction to Material Chemistry” Allcock H. R., <i>John Wiley & Sons, Inc.</i>	2008
2.	“Material Chemistry” Fahlman B. D., <i>Springer</i>	2011
3.	“Nanoscale Materials in Chemistry” Klabunde K. J., Richards R. M., 2 nd edn., <i>John Wiley & Sons, Inc.</i>	2009
4.	“Material Science and Engineering: An Introduction” Callister Jr W. D., Rethwisch D. G., 8 th edn., <i>John Wiley & Sons, Inc.</i>	2009
5.	“Carbon Nanomaterials” Mathur R. B., Singh B. P., Pande S., <i>Taylor & Francis</i>	2017
6.	“Solid State Chemistry and its Applications” , West A. R., Reprint, <i>Wiley India</i>	2013
7.	“Introduction to Ceramics” , Kingery W. D., Bowen H. K., Uhlmann D. R., <i>Wiley-Interscience</i>	1976
8.	“Introduction to Polymer Science and Chemistry” , Chanda M., <i>Taylor and Francis</i>	2006

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: Department of Chemistry

1. Subject Code: CYN-703 **Course Title:** Advanced Materials Characterization Techniques

2. Contact Hours: L: 3 T: 1 P: 0

3. Examination Duration (Hrs.): Theory: 3 Practical: 0

4 Relative Weightage: CWS: 20-35 PRS: 0 MTE: 20-30 ETE: 40-50 PRE: 0

5. Credits: 4 **6. Semester:** Autumn/Spring **7. Subject Area:** PEC

8. Pre-requisite: Basic knowledge in chemistry and physics

9. Objective: To provide knowledge on characterization of materials

10. Details of Course:

S. No.	Contents	Contact Hours
1.	X-ray diffraction. Concept of lattice, crystalline state, types of crystal system and structures, X-ray sources, filters and monochromators, detectors, principle of X-ray diffraction, amplitude and phase of diffraction, structure factors, systematic absences, experimentation – powder method, interpretation of diffraction data – indexing and lattice parameters, lattice parameter refinement and pattern simulation, Rietveld refinement using X-ray data.	10
2.	Microscopic techniques. Principle of electron-matter interaction, transmission electron microscope (TEM) -instrumentation, electron sources – field emission, condenser lenses, objective lenses, sample stage, image creation- bright field and dark field images, specimen preparation, electron diffraction pattern and indexing, high resolution TEM; scanning electron microscope - instrumentation, secondary and back scattered electron images, energy dispersive X-ray analysis and elemental mapping; atomic force microscopy - concepts and instrumentation	10
3	Texture analysis. N ₂ sorption, adsorption isotherms-BET and Langmuir, method for estimation of specific surface area, pore size distribution, pore volume analysis of porous materials.	4
4.	X-ray photoelectron spectroscopy. Electronic structure of atoms and ions, stationary state notation, photoelectric effect and work function; instrumentation-vacuum level, X-ray sources, electron sources, ion sources, energy analyser, detector, imaging; data collection and quantification - analysis procedures, photoelectron intensities, depth profiling, spectral interpretation - binding energy and chemical shifts; case studies.	7
5.	Thermal and magnetic measurements. Thermogravimetric analysis, differential thermal analysis, differential scanning calorimetry; magnetic susceptibility, hysteresis (M-H), field-cooled and zero field-cooled measurements, magnetization, VSM and SQUID magnetometry; AC susceptibility, case studies.	6
6.	Optical and Raman spectroscopy. Diffuse reflectance spectroscopy, ATR, photoluminescence, Raman spectroscopy-principle, instrumentation and application in carbonaceous materials, metal oxides and chalcogenides.	5
	Total	42

11. Suggested Books:

Sl. No.	Authors/ Title/ Publisher	Year of Publication
1.	“Principles of Instrumental Analysis ” Skoog D.A., Holler F.J., and Crouch S.R., <i>6th Ed., Cengage</i>	2014
2.	“Solid State Chemistry and its Applications” West A.R., <i>John Wiley & Sons</i>	2002
3.	“Transmission Electron Microscopy: A textbook for Materials Science” Williams D.B. and Carter C.B., 2nd Edition, Springer	2003
4.	“Scanning Electron Microscopy and X-Ray Microanalysis” Goldstein, J., Newbury, D.E., Joy, D.C., Lyman, C.E., Echlin, P., Lifshin, E., Sawyer, L and Michael J.R., 3rd Edition, <i>Springer</i>	2003
5.	“X-ray Photoelectron Spectroscopy: An Introduction to Principles and Practices” Van der Heide, P., <i>John Wiley & Sons</i>	2012
6.	“Surface Area and Porosity Determinations by Physisorption” Condon, J., <i>Elsevier Science</i>	2006
7.	“Magnetic Materials: Fundamentals and Device Applications” Nicola, S., <i>Cambridge University Press</i>	2003