University of Kerala

Discipline	CHEMISTRY				
Course Code	**UK4DSECHE206**				
Course Title	**CHEMISTRY OF NANOMATERIALS- II**				
Type of Course	**DSE**				
Semester	4				
Academic Level	200 - 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites	UK3DSECHE206 (preferable)				
Course Summary	This course provides an introductory understanding of the four primary classes of materials: metals, ceramics, polymers, and composites. Students will learn various processing techniques and the characterization of materials through diffraction, spectroscopy and microscopic techniques.				

Detailed Syllabus:

Module	Unit	Contents CHEMISTRY OF NANOMATERIALS- II	Hrs 75
I	**METALS AND ALLOYS**		**9**
	1	Alloys: Types of metal alloys- Ferrous alloys (carbon steels, alloy steels, stainless steels and non-ferrous alloys (aluminium, copper, nickel alloys).	4
	2	Fabrication and processing of metals Metal forming processes- forging, rolling, extrusion, and drawing. Casting techniques- sand casting, die casting, investment casting, lost-foam casting, and continuous casting. Thermal processing of metals- annealing, heat treatment, precipitation hardening processes.	5
II	**CERAMICS AND POLYMERS**		**18**
	3	Ceramics- introduction. Types of ceramics- glasses, clay, refractories, abrasives, cements.	3
	4	Fabrication and processing of ceramics Glass-forming processes- pressing, blowing, drawing, and fiber-forming. Particulate-forming processes: powder pressing, hydroplastic forming, slip casting, tape casting, and cementation.	4

	5	Types of polymers and products- plastics, fibres, and elastomers. Specialty polymers- coatings, adhesives, films, and foams (elementary ideas only).	4
	6	Polymer additives- fillers, plasticizers, stabilizers, and flame retardants.	3
	7	Synthesis and processing techniques of polymers Polymerisation methods- addition polymerization and condensation polymerization. Forming techniques- compression moulding, transfer moulding, injection moulding, and blow moulding.	4
III	**COMPOSITES**		**9**
	8	Introduction. Classification of composite materials: particle-reinforced, fibre-reinforced and structural composites.	1
	9	Particle-reinforced composites- large-particle and dispersion-strengthened composites.	3
	10	Fibre-reinforced composites- fiber phase, matrix phase, and classification based on matrix type (polymer, metal, and ceramic-matrix composites).	3
	11	Structural composites- laminar composites and sandwich panels.	2
IV	**CHARACTERIZATION OF MATERIALS**		**9**
	12	Diffraction techniques -X-ray diffraction (XRD), electron diffraction.	2
	13	Thermal analysis- thermogravimetry (TGA), differential thermal analysis (DTA), differential scanning calorimetry (DSC).	3
	14	Electron microscopy - scanning electron microscopy (SEM), and transmission electron microscopy (TEM).	2
	15	Surface microscopy- atomic force microscopy (AFM), scanning-tunnelling microscopy (STM)	2
V	**PRACTICALS: A minimum of 7 practical experiments from sections A, B and C must be performed and reported.**		**30**
		A. Crystallization Techniques 1. Demonstration of various crystallization techniques (any two): i) Slow cooling (crystallization of benzoic acid from water). ii) Slow evaporation from pure solvent (crystallization of copper sulphate from water). iii) Slow evaporation from a mixture of solvents (crystallization of acetanilide using ethanol and water). **B. Synthesis of Materials** 1. Polymer synthesis (any two): i) Polyaniline ii) Polystyrene (PS), and iii) Polymethyl methacrylate (PMMA) 2. Biopolymer processing (any one): i) chitosan biopolymer film ii) cellulose biopolymer film iii) starch biopolymer film 3. Synthesis of metal oxides/phosphate materials via sol-gel/ hydrothermal/ combustion routes (any one): i) ZnO ii) Ca_3PO_4	

		C. Characterization of Materials (open ended) Students should acquire the skill to index PXRD pattern and thermograms of the following materials. i) Powder X-ray diffraction (any one) Determine the cubic system (primitive/FCC/BCC) by indexing the PXRD data of the following materials: a) α-Polonium b) CsCl c) NaCl ii) Thermogravimetric Analysis (any one) Students should learn to interpret the TGA diagram of: a) $CaCO_3.5H_2O$ b) Aluminum hydroxide $Al(OH)_3$	

References

1. W.D Callister. Jr, *Materials Science and Engineering*, Wiley India Pvt. Ltd, 2007
2. Raghavan V, *Materials Science and Engineering*, 4th Edition, Prentice Hall of India, 1998
3. Joel I. Gersten and Frederick W. Smit, *The Physics and Chemistry of Materials*, Wiley, 2001
4. Fahlman, B.D., *Materials Chemistry*, Springer, 2007
5. James F. Shackelford, *Introduction to Materials Science for Engineers, Pearson, 2015*
6. David G. Rethwisch, *Materials Science and Engineering: An Introduction, 2010*
7. William F. Smith and Javad Hashemi, *Foundations of Materials Science and Engineering*; 5th Edition, 2009
8. F.C. Campbell, *Elements of Metallurgy and Engineering Alloys*, ASM International, 2008.
9. J. Beddoes, M.J. Bibby, *Principles of Metal Manufacturing Processes*, Elsevier, 2003.
10. G.E. Dieter, *Mechanical Metallurgy*, McGraw-Hill, 3 rd ed., 1986.
11. E. Degarmo, J.T. Black and R.A. Kohser, *Materials and Processes in Manufacturing*, 9th ed., Wiley, 2002.
12. S. Kalpakjian, S.R. Schmid, *Manufacturing Engineering and Technology*, 6th ed., Pearson, 2009
13. J. Urbanski, W. Czerwinski, K. Janicka, F. Majewska, H. Zowall, *Handbook for analysis of synthetic polymer and plastics*, Ellis Harwood Limited, Chichester, 1977
14. A. I. Vogel, "*Elementary Practical Organic Chemistry*" Longmans, 1970.
15. Enrique Saldivar- Guerra, Eduardo Vivaldo-Lima, *Handbook of Polymer Synthesis, Characterization and Processing*, Wiley, 2013.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Apply knowledge of nanomaterial chemistry to select and process suitable ferrous and non-ferrous alloys	An	PSO-1,2

	using appropriate fabrication, forming, casting, and thermal treatment techniques for targeted material performance.		
CO-2	Analyse the composition, classification and processing techniques of ceramics and polymers, evaluating their suitability and performance in nanomaterial applications.	An	PSO-1,3
CO-3	Evaluate the performance, suitability, and structural integrity of different classes of nanomaterial-based composites by critically analysing their component phases and reinforcement types for targeted applications.	E	PSO-1,3
CO-4	Design and execute a comprehensive characterization strategy for nanomaterials by selecting, integrating, and interpreting data from diffraction, thermal analysis, electron microscopy, and surface microscopy techniques.	C	PSO-1,3
CO-5	Design and fabricate nanomaterials through controlled crystallization and synthesis routes and innovatively interpret PXRD and TGA data to classify crystal systems and thermal behavior of the prepared materials.	C	PSO-1,2,4

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-

Name of the Course: CHEMISTRY OF NANOMATERIALS- II

Credits: 3:0:1 (Lecture:Tutorial:Practical)

CO No.	CO	PO/ PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
1	CO-1	PSO-1,2	An	F, C	L	-
2	CO-2	PSO-1,3	An	C	L	-
3	CO-3	PSO-1,3	E	M	L	-
4	CO-4	PSO-1,3	C	M	L	-
5	CO-5	PSO-	C	P	L/T	P

		1,2,4,5				

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs:

	PSO 1	PSO 2	PSO 3	PSO 4	PS O5	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO 1	3	3	-	-	-	3	2	-	-	-	-	-	-
CO 2	1	-	3	-	-	1	3	-	-	-	-	-	-
CO 3	3	-	2	-	-	3	3	-	-	-	-	-	-
CO 4	1	-	3	-	-	3	2	-	-	-	-	-	-
CO 5	3	3	2	-	-	2	2	-	-	-	-	-	-
CO 6	2	3	3	-	2	2	3	-	-	-	-	-	-

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓			✓
CO 2	✓			✓
CO 3	✓		✓	✓
CO 4		✓		✓
CO 5	✓	✓		✓
CO 6	✓		✓	