FACULTIES OF HUMANITIES AND SCIENCE

DEPARTMENT OF CHEMISTRY

M.Sc CHEMISTRY - Elective Subjects

Faculties of Humanities and Science- Department of Chemistry M.Sc Chemistry-2018- 2020 Syllabus-Full Time

SEMESTER 1

Course Code.	Course Title	L	T	P	C
HMCH18G01	Physical Chemistry-I	4	0	0	4
HMCH18G02	Inorganic Chemistry-I	4	0	0	4
HMCH18G03	Organic Chemistry-I	4	0	0	4
HMCH18GE1 HMCH18GE2	**Elective-I** • Chemistry of Main group elements • Bio organic Chemistry	3	0	0	2
	Practical				
HMCH18L01	Physical Chemistry Practical	0	0	5	2
HMCH18L02	Inorganic quantitative Analysis	0	0	5	2
	Total Credits 18				

SEMESTER – 2

Course Code.	Course Title	L	T	P	C
HMCH18G04	Physical Chemistry-II	4	0	0	4
HMCH18G05	Inorganic Chemistry-II	4	0	0	4
HMCH18G06	Organic Chemistry-II	4	0	0	4
HMCH18GE3 HMCH18GE4	Elective-II • Chemistry of Natural products • Special topics in Organic synthesis	3	0	0	2
	Practical				
HMCH18L03	Organic qualitative Analysis and Synthesis	0	0	5	2
HMCH18L04	Inorganic qualitative Analysis and Synthesis	0	0	5	2
	Total Credits.....18				

SEMESTER 3

Sub. Code.	Course Title	L	T	P	C
HMCH18G07	Coordination Chemistry	5	0	0	4
HMCH18G08	Molecular Spectroscopy	5	0	0	4
HMCH18G09	Photochemical and Electrochemical studies	5	0	0	4
HMCH18GE5 HMCH18GE6	Elective –III • Material Chemistry • Nano Chemistry	3	0	0	2
	Practical				
HMCH18L05	Organic Quantitative Analysis and Synthesis	0	0	6	4
	Total Credits.....18				

SEMESTER -I

Subject Code: **HMCH18GE1**	Subject Name: **CHEMISTRY OF MAIN GROUP ELEMENTS**	L	T	P	C
	Prerequisite : Basic principles in General Chemistry	**3**	**0**	**0**	**2**

L : Lecture T : Tutorial P: Practical C : Credits

OBJECTIVES

- To understand the basic concepts about s -block elements and p -block elements
- To gain the sound knowledge about boron compounds and electron deficient boranes
- To know about different allotropic forms of carbon, basics of nanocarbons like SWCNTs, MWCNTs.
- To know the importance of various organometallic compounds
- To gain knowledge about nitrogen and halogen compounds

COURSE OUTCOMES (Cos)

Students completing this course were able to

CO1	Understand the basic concepts electron rich and electron deficient hydrides, and applications of crown ethers.
CO2	Understand structure and types of boron hydrides, interconversion of higher boranes to lower boranes
CO3	Understand different allotropic forms of carbon and new nano based carbon materials like single walled and multiwalled carbon nanotubes
CO4	Gain knowledge about preparation, properties, structure of different organometallic compounds
CO5	Gain knowledge about pseudo halogens, nitrogen compounds, molecular sieves

Mapping of Course Outcome with Program Outcome (POs)

Cos/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**
CO1	3	1	3	2	3	2	3	3	3	2	2
CO2	3	1	3	2	3	3	3	2	3	1	2
CO3	3	2	3	2	3	3	3	3	3	2	1
CO4	3	2	3	2	3	3	3	3	3	1	1
CO5	3	2	2	1	3	3	3	3	3	2	2

COs /PSOs	**PSO-1**	**PSO-2**	**PSO-3**	**PSO-4**	**PSO-5**	**PSO-6**
CO1	2	2	1	2	3	2
CO2	1	3	3	2	1	2
CO3	3	2	1	1	2	3
CO4	1	2	2	3	2	2
CO5	3	3	1	2	3	2

3/2/1 Indicates Strength Of Correlation, 3 – High, 2- Medium, 1- Low

Category	Basic Sciences	Engg.Science	Humanities & social Science	Program Core	Program Elective	Open Elective	Practical/Proj ect	Internships/ Technical Skills	Soft Skills
					√				

Code. No	Course Title	L	T	P	C
HMCH18GE1	Chemistry of Main group elements	3	0	0	2

OBJECTIVES

- To understand the basic concepts about s and p-block elements
- To know the importance of various organometallic compounds

UNIT- I HYDROGEN, ALKALI & ALKALINE EARTH METALS AND NOBLE GASES **6hrs**

Hydrides – classification – electron deficient, electron precise & electron rich hydrides. PH_3,SbH_3, & AsH_3 - Solutions in non-aqueous media – Application of crown ethers in extraction of alkali & alkaline earth metals – Noble gases – synthesis, properties, uses, structure & bonding based on VSEPR.

UNIT- II BORON GROUP **6hrs**

Boron Hydrides – preparation, structure & bonding with respect to LUMO, HOMO – inter conversion of lower and higher boranes – boron nitride – Inorganic Benzene – Borazine.

UNIT- III CARBON GROUP **6hrs**

Allotropes of carbon – C_{60} (fullerenes) and other compounds– intercalation compounds of Graphite – carbon nanotubes – synthesis, properties, structure – single walled, multi walled – applications.

UNIT- IV ORGANOMETALLIC COMPOUNDS **6hrs**

Classification - Synthesis, properties, uses, structures and reactions of organometallic compounds of Li, Mg, Ca, Sn, Pb, Ga, & Bi.

UNIT- V NITROGEN & HALOGEN GROUPS **6hrs**

Nitrogen activation – oxidation states of nitrogen & their inter conversion – PN & SN compounds – Ring, cage and cluster compounds of p-block elements – Silicates including zeolites - Silicones – Molecular sieves – Ultramarins – Inter halogens – Pseudo halogens – oxy acids & oxo anions of Halogens – Preparation, properties and uses.

REFERENCE BOOKS

1. Advanced Inorganic Chemistry, F.A.Cotton, G.Wilkinson, C.A.Murollo, M.Bochmann 6^{th} edition (2003).
2. Inorganic Chemistry, P.W.Atkins, 4^{th} edition, Oxford 2003.

Subject Code: **HMCH18GE2**	Subject Name: **Bio Organic Chemistry**	L	T	P	C
	Prerequisite : Basic principles of biomolecules in Chemistry	**3**	**0**	**0**	**2**

L : Lecture T : Tutorial P: Practical C : Credits

OBJECTIVES

- To understand the organic chemistry of biomolecules like amino acids, peptides, nucleic acids and carbohydrates
- To learn about how enzymes and coenzymes work
- The number of reacting substrates decides the order of reaction
- To know about various forms and chemical properties of DNA and RNA
- General definition, classification and synthesis of carbohydrates.

COURSE OUTCOMES (Cos)

Students completing this course were able to

CO1	To know the basic structure of amino acids, different ways of classification, understand physical and chemical properties of amino acids, various functions and biological importance of amino acids, peptides and proteins
CO2	To learn about enzymes and how they are different from chemical catalysts, history and discovery of enzymes, bind to substrates showing saturation kinetics.
CO3	Learn about the structure and function of biotin, co-enzymes A, thiamine pyrophosphate, know the three important co-enzymes, like nicotinamide nucleotides, flavin nucleotides and lipoic acid.
CO4	Know about nucleotides are monomers that frame the DNA and RNA, nucleotides comprise of pentose sugar, nitrogenous bases and phosphate, understand polynucleotides (DNA or RNA) are elements of heredity.
CO5	General definition and basis of classification of carbohydrates, types and chemical properties of monosaccharaides and disaccharides and their properties. Function of carbohydrates. Polysaccharides and its types.

Mapping of Course Outcome with Program Outcome (POs)

Cos/Pos	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**
CO1	3	2	2	2	2	2	3	3	2	2	2
CO2	3	2	3	1	2	3	3	2	2	1	3
CO3	3	2	2	2	1	2	3	3	1	2	3
CO4	3	2	3	1	1	3	3	3	2	1	2
CO5	3	2	3	1	2	3	3	3	1	2	2

COs /PSOs	**PSO-1**	**PSO-2**	**PSO-3**	**PSO-4**	**PSO-5**	**PSO-6**
CO1	2	3	1	3	3	2
CO2	3	3	2	3	2	3
CO3	3	2	1	3	2	3
CO4	3	3	2	3	2	2
CO5	2	3	2	3	3	3

3/2/1 Indicates Strength Of Correlation, 3 – High, 2- Medium, 1- Low

Category	Basic Sciences	Engg.Science	Humanities & social Science	Program Core	Program Elective	Open Elective	Practical/Proj ect	Internships/ Technical Skills	Soft Skills
				√					

SEMESTER- I

HMCH18GE2	**BIO ORGANIC CHEMISTRY**	3	0	0	2

OBJECTIVES

- To understand the organic chemistry of biomolecules like amino acids, peptides, nucleic acids and carbohydrates.
- To learn about how enzymes and coenzymes work.

UNIT-I AMINO ACIDS, PEPTIDES AND PROTEINS 6hrs

Amino acids: acid base properties, isoelectric point, separation, resolution of racemic mixtures of amino acids, asymmetric synthesis,Peptide bonds: peptide secondary structures and their stabilization, strategies for peptide synthesis, automated peptide synthesis.Proteins: primary, secondary, tertiary and quaternary structures, protein denaturation, naturalβ-amino acids and β-peptides; β-turn peptidomimetics, β-lactam based peptidomimetics.

UNIT-II: ENZYMES 6hrs

Classification of enzymes, enzyme catalysis and kinetics, nucleophilic, acid, base and metal- ion catalysis, the catalytic triad, mechanisms of carboxypeptidase A, serine proteases and lysozyme, enzyme inhibition and drug design, enzymes in organic synthesis; antibody catalyzed organic reactions.

UNIT-III: ORGANIC CHEMISTRY OF COENZYMES 6hrs

NIacin and its role in redox reactions, mechanisms for pyridine nucleotide coenzymes, flavin adenine dinucleotide and flavin mononucleotide, mechanisms for flavin nucleotide coenzymes, thiamine pyrophosphate and its role in the pyruvate decarboxylase mechanism, biotin and its role in the pyruvate decarboxylase system, pyridoxal phosphate and its role in decarboxylation, transamination, racemization of amino acids, C-C bond cleavage and α,β- elimination.

UNIT-IV: BIO ORGANIC CHEMISTRY OF NUCLEIC ACIDS 6hrs

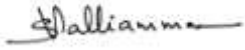
Nucleic acids: nucleosides and nucleotides, conformation of sugar-phosphate backbone, hydrogen bonding by bases,the double helix, A, B, and Z double helices, stability of double helix, replication, transcription and translation, DNA intercalators, chemical synthesis of DNA, catalytic RNA, siRNA, micro RNA, synthesis and applications of unnatural nucleosides, fluorescently labeled nucleosides and oligonucleotide probes, homogeneous DNA detection, microarray based DNA detection, basics of peptide nucleic acids.

UNIT-V: CARBOHYDRATES 6hrs

Classification of carbohydrates, configuration, redox reactions of monosaccharides, Kiliani- Fischer synthesis, Ruff degradation, hemiacetals and cyclic structure of monosaccharides, glycosides, anomeric effect, reducing and non-reducing sugars, disaccharides and polysaccharides.

REFERENCE BOOKS

1. P. Y. Bruice, Organic Chemistry, 5th Ed., Pearson, 2014.
2. D.V. Vranken and G.A. Weiss, Introduction to Bioorganic Chemistry and Chemical Biology, 1st Ed., Garland Science, 2012.
3. T. K. Lindhorst, Essentials of Carbohydrate Chemistry and Biochemistry, 3rd Ed., Wiley 2007.
4. N. Sewald and H.D Jakubke, Peptides: Chemistry and Biology, 2nd Ed. Wiley, 2009.



SEMESTER -II

Subject Code: **HMCH18 GE3**	Subject Name: **CHEMISTRY OF NATURAL PRODUCTS**	L	T	P	C
	Prerequisite : **Basic Organic chemistry**	**3**	**0**	**0**	**2**

L : Lecture T : Tutorial P: Practical C : Credits

OBJECTIVES

- To gain knowledge about the importance of various natural products.
- To understand the techniques involved in the extraction and methods of determination of structure of alkaloids, terpenoids and pigments
- To understand and appreciate the chemistry of steroids and hormones and their importance in the living systems
- To learn about aromaticity in various compounds.

COURSE OUTCOMES (Cos)

Students completing this course were able to

CO1	Identify of certain compounds in the opium family by knowing the chemistry of them.
CO2	Identify isolate terpenoids, so phytochemical studies can be done.
CO3	Involve in research of pigments and their synthesis.
CO4	Indulge in working with steroids and its function so thereby biological investigations can be carried out.
CO5	Carry out research and study about organic molecules.

Mapping of Course Outcome with Program Outcome (POs)

Cos/Pos	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**
CO1	3	3	3	3	3	3	3	2	1	2	3
CO2	3	3	3	3	3	3	3	2	1	2	3
CO3	3	3	3	3	3	3	3	3	1	2	3
CO4	3	3	3	3	3	3	3	2	1	2	3
CO5	3	3	3	3	3	3	3	3	2	2	3

COs /PSOs	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	2	3	3	3	3	3
CO2	2	3	3	3	3	3
CO3	2	3	3	3	3	3
CO4	2	3	3	3	3	3
CO5	2	3	3	3	3	3

3/2/1 Indicates Strength Of Correlation, 3 – High, 2- Medium, 1- Low

Category	Basic Sciences	Engg.Science	Humanities & social Science	Program Core	Program Elective	Open Elective	Practical/Project	Internships/ Technical Skills	Soft Skills
					√				

Code. No	Course Title	L	T	P	C
HMCH18GE3	Chemistry of Natural Products	4	0	0	4

OBJECTIVES

- To gain knowledge about the importance of various natural products.
- To understand the techniques involved in the extraction and methods of determination of structure of alkaloids, terpenoids and pigments
- To understand and appreciate the chemistry of steroids and hormones and their importance in the living systems

UNIT-I ALKALOIDS **6hrs**

Introduction to alkaloids - Isolation-properties, General methods of structural elucidation of Tropane alkaloids - Atropine, Cocaine. Quinoline alkaloids – Quinine, Cinchonine. Iso Quinoline alkaloids - papaverine. Opium alkaloids - Morphine. Indole alkaloids - Ergotamine, Reserpine. Tropolone alkaloids - Colchicine. Phenylethylamine alkaloids - Ephedrine, Adrenaline.

UNIT-II TERPENOIDS **6hrs**

Terpenoids - introduction, general properties, isolation – Isoprene and special isoprene rule - general methods of determination of structure of Camphane, Borneols, isoborneols, Camphene norborane, sesquiterpenoids - Acyclic - Farnesol monocyclic - Bisabolene. Bicyclic α-cadinene. Diterpenoids - phetol. Triterpenoids - squalene.

UNIT-III NATURAL PIGMENTS **6hrs**

Natural pigments – introduction to natural pigments - Anthocyanins. Properties, detection, isolation – determination of structure of Flavone, Flavanol – classification, properties, general methods of structural elucidation of phorphyrin.

UNIT-IV STEROIDS AND HARMONES **6hrs**

Steroids – Introduction, Diel's hydrocarbon – nomenclature of sterols – cholesterol – lanosterol – stigmasterol. Bile acids – introduction – isolation – constitution and functions. Hormones – progesterone, testosterone – aldosterone and throxine.

UNIT- V AROMATICITY OF SOME CARBOCYCLIC COMPOUNDS **6hrs**

Theories of aromaticity – antiaromaticity – non-aromaticity – three and five membered carbocyclic compounds – tropone –tropolone – azulene – annulenes.

Text books

1. O.P Agarwal, Chemistry of Organic Natural Products, Vol .1 Goel Publishing House, Meerut,1997
2. O.P Agarwal, Chemistry of Organic Natural Products, Vol .2 Goel Publishing House, Meerut,1997
3. T.L Gilchrist, Heterocyclic chemistry, Longman Scientific and Tech, 1985.
4. Pelletier,Chemistry of alkaloids, Van Nostrand Reinhold Co,2000.
5. Shoppe, Chemistry of the steroids, Butterworthes , 1984.

Subject Code: **HMCH18GE4**	Subject Name: **SPECIAL TOPICS IN ORGANIC SYNTHESIS**	L	T	P	C
	Pre requisite: Basic principles in organic Chemistry	**3**	**0**	**0**	**2**

L : Lecture T : Tutorial P: Practical C : Credits

OBJECTIVES

- To acquire knowledge about asymmetric synthesis and organocatalysis.
- To learn about the applications of enzymes in organic synthesis.
- To gain knowledge about enolate chemistry, carbenes in organo catalysis
- To know about nomenclature and structure of coenzymes
- To know about different biocatalysis in organic reactions

COURSE OUTCOMES (Cos)

Students completing this course were able to

CO1	Discuss the types of asymmetric synthesis controlled by chiral auxiliary, chiral catalyst, chiral substrate and chiral reagent with examples..
CO2	Acquire knowledge about different catalysis like acid base catalysis, enanime catalysis
CO3	Explain organo catalysis, chemistry of enolates and various catalysis reactions.
CO4	Explain Classification, structure, and biological functions of different type of Coenzymes.
CO5	Acquire knowledge about different enzyme synthesis reactions.

Mapping of Course Outcome with Program Outcome (POs)

Cos/Pos	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**
CO1	3	1	2	1	3	2	3	3	3	2	2
CO2	3	1	3	2	3	3	3	2	3	1	2
CO3	3	2	3	2	3	3	3	3	3	2	1
CO4	3	1	2	2	3	3	3	3	3	1	1
CO5	3	2	2	1	3	3	3	3	3	2	2

COs /PSOs	**PSO-1**	**PSO-2**	**PSO-3**	**PSO-4**	**PSO-5**	**PSO-6**
CO1	2	2	1	2	3	1
CO2	1	3	3	2	1	2
CO3	3	2	1	1	2	1
CO4	1	1	2	1	2	2
CO5	3	3	1	2	3	2

3/2/1 Indicates Strength Of Correlation, 3 – High, 2- Medium, 1- Low

Category	Basic Sciences	Engg.Science	Humanities & social Science	Program Core	Program Elective	Open Elective	Practical/Proj ect	Internships/ Technical Skills	Soft Skills
					√				

Code. No	Course Title	L	T	P	C
HMCH18GE4	Special topics in Organic Synthesis	4	0	0	4

OBJECTIVES

To acquire knowledge about asymmetric synthesis and organocatalysis.

To learn about the applications of enzymes in organic synthesis.

UNIT-I: ASYMMETRIC SYNTHESIS **6hrs**

Asymmetric synthesis: chiral auxiliaries, methods of asymmetric induction, substrate, reagent and catalyst controlled reactions, determination of enantiomeric and diastereomeric excess, enantio-discrimination, resolution – optical and kinetic, asymmetric oxidation [epoxidation: Sharpless, Jacobsen, Shi), dihydroxylation (Sharpless)], asymmetric reduction (Noyori, Corey, Pfaltz), stereoselective aldol reactions (Cram's rule and Felkin Anh models), auxillary controlled stereoselection: Evans oxazolidones.

UNIT-II: ORGANO CATALYSIS-I **6hrs**

Introduction to organocatalysis, Lewis base catalysis, iminium catalysis, enamine catalysis, Lewis acid catalysis, Bronsted acid and base catalysis, examples.

UNIT-III: ORGANO CATALYSIS-II **6hrs**

Carbenes as organocatalysts, types of different NHCs and their synthesis, NHC catalyzed umpolung, NHC catalyzed transesterification reactions, homo and cross benzoin type reactions, Stetter reaction, enolate chemistry, homoenolate derived reactions, addition to ketenes and analogs, oxidative NHC catalysis, cooperative catalysis with metal catalysts, cooperative catalysis with other organocatalysts.

UNIT-IV: BIOCATALYSIS IN ORGANIC SYNTHESIS-I **6hrs**

Introduction to biocatalysts, advantages and disadvantages of biocatalysts, isolated enzymes vs. whole cell systems, brief overview of structure of enzymes, mechanistic aspects of enzyme catalysis, classification and nomenclature, coenzymes, enzyme sources, biocatalysed hydrolytic reactions, hydrolysis of amides, esters, epoxides and nitriles, biocatalytic reduction reactions, recycling of cofactors, reduction of aldehydes, ketones and C=C bonds.

UNIT-V: BIOCATALYSIS IN ORGANIC SYNTHESIS-II **6hrs**

Oxidation reactions, oxidation of alcohols and aldehydes, biocatalytic carbon-carbon bond formations, aldol reaction, Michael-type additions, thiamine-dependant benzoin condensation, cyanohydrin formation, amino transfer reactions, halogenations and dehalogenations, enzymes in organic solvents, ester synthesis, lactone synthesis, amide synthesis, peptide synthesis, artificial enzyme mimics, and catalytic antibodies.

REFERNCE BOOKS

1. R. Gawley and J. Aube, Principles of Asymmetric Synthesis, 2nd Ed., Elsevier, 2012.
K. Faber, Biotransformations in Organic Chemistry, 6th Ed., Springer, 2011

SEMESTER -III

Subject Code: **HMCH18E5**	Subject Name: **MATERIAL CHEMISTRY**	L	T	P	C
	Prerequisite : **Solid state chemistry and Analytical chemistry**	**3**	**0**	**0**	**2**

L : Lecture T : Tutorial P: Practical C : Credits

OBJECTIVES

- To get idea about the various materials in the field of chemistry.
- To gain knowledge about the concepts involved in crystalline, amorphous and nano materials.
- To understand about the properties and characterization of the various materials

COURSE OUTCOMES (Cos)

Students completing this course were able to

CO1	Understand solid state and thereby synthesize crystalline materials.
CO2	Carry out research and study the properties of various new materials
CO3	Target oriented application and synthesize dimension based materials.
CO4	Study different materials especially in electric and electronic fields.
CO5	Handle and utilize different analytical instruments to study the materials.

Mapping of Course Outcome with Program Outcome (POs)

Cos/Pos	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**
CO1	3	3	3	3	3	3	3	3	2	3	3
CO2	3	3	3	3	3	3	3	3	2	3	3
CO3	3	3	3	3	3	3	3	3	2	3	3
CO4	3	3	3	3	3	3	3	3	2	3	3
CO5	3	3	3	3	3	2	3	3	2	3	3

COs /PSOs	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	2	2	3	3	3	3
CO2	3	3	3	3	3	3
CO3	3	3	3	3	3	3
CO4	3	2	3	3	3	3
CO5	3	2	2	3	3	2

3/2/1 Indicates Strength of Correlation, 3 – High, 2- Medium, 1- Low

Category	Basic Sciences	Engg.Science	Humanities & social Science	Program Core	Program Elective	Open Elective	Practical/Project	Internships/ Technical Skills	Soft Skills
					√				

Code. No	Course Title	L	T	P	C
HMCH18GE5	Material Chemistry	3	0	0	2

OBJECTIVES

- To get idea about the various materials in the field of chemistry.
- To gain knowledge about the concepts involved in crystalline, amorphous and nano materials.
- To understand about the properties and characterisation of the various materials

UNIT-I: CRYSTALLINE MATERIALS 4hrs

Fundamentals of lattice, unit cell, atomic coordinate, Bravais Lattices, crystal's direction and planes, crystal structures, representation of crystal Structures, defects: point, line, surface, bulk, synthetic approaches for crystalline functional materials - chemical and physical methods.

UNIT-II: AMORPHOUS AND ELECTRICAL MATERIALS 6hrs

Amorphous solid, oxide glasses, chalcogenide glasses, amorphous carbon, graphite, diamond, alkaline graphite, polymer compounds, band theory, metals, insulators and semiconductors, optical properties of materials, band gap, doping and devices.

UNIT-III: NANOMATERIALS 6hrs

Nanomaterials, quantum confinement and quantum nanostructures, surface energy and surface area of nanomaterials, fabrication methods of nanomaterials, top-down and bottom-up approaches, 0D,1D and 2D nanomaterials, examples and applications.

UNIT-IV: PROPERTIES OF MATERIALS 6hrs

Mechanical properties: fractures of metal, ductile fracture, brittle fracture, toughness and impact testing, magnetic properties: para, ferro, anti-ferro and ferri, electrical properties: thermoelectric, dielectric, piezoelectric, pyroelectric and ferroelectric effect.

UNIT-V: CHARACTERISATION OF MATERIALS 8hrs

Spectroscopic methods: UV-Vis, IR and Raman, X-ray diffraction, electron microscopy: SEM, TEM and XPS, probe analysis: AFM, Instrumentation, basic working principle and examples in analysis for all the above**.**

REFERENCE BOOKS

1. A. R. West, Basic Solid State Chemistry, 2nd Ed., John Wiley & Sons Ltd., 1999.
2. K. J. Klabunde, Nanoscale materials in Chemistry, Wiley Interscience, New York, 2001
3. C. Giacovazzo, Fundamentals of Crystallography, Oxford University Press, 2002.
4. W. D. Callister and D. G. Rethwisch, Materials Science and Engineering: An Introduction, 9th Ed., Wiley, 2013.
5. D. J. Ward, Materials Science, Lerner Classroom, 2008.

Subject Code: **HMCH18GE6**	Subject Name: **NANOCHEMISTRY**	L	T	P	C
	Prerequisite : **Basic principles in nano Chemistry**	**3**	**0**	**0**	**2**

L : Lecture T : Tutorial P: Practical C : Credits

OBJECTIVES

- To acquire basic knowledge about nanochemistry.
- To learn the synthesis of nanomaterials, characterization and applications.
- To acquire basic knowledge about characterization techniques involved
- To learn about carbon clusters and carbon nanotubes
- To acquire knowledge about nanocatalysis

COURSE OUTCOMES (Cos)

Students completing this course were able to

CO1	Understand the basic concepts of nanotechnology, shape, size, surface and defects of nanomaterials
CO2	Understand the synthesis of zero, one and two dimensional nanomaterials.
CO3	Can able to analyze sample by different characterization techniques like SEM, TEM, XRD, XPS.
CO4	Understand the chemistry of carbon clusters and the synthesis of SWCNTs,MWCNTs.
CO5	Understand the fundamentals of nanmaterials in catalysis reactions.

Mapping of Course Outcome with Program Outcome (POs)

Cos/Pos	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**
CO1	3	1	2	1	3	2	3	3	3	2	2
CO2	3	1	3	2	3	3	3	2	3	1	2
CO3	3	2	3	2	3	3	3	3	3	2	1
CO4	3	1	2	2	3	3	3	3	3	1	1
CO5	3	2	2	1	3	3	3	3	3	2	2

COs /PSOs	**PSO-1**	**PSO-2**	**PSO-3**	**PSO-4**	**PSO-5**	**PSO-6**
CO1	2	2	1	2	3	1
CO2	1	3	3	2	1	2
CO3	2	2	1	1	2	1
CO4	1	1	2	1	2	2
CO5	2	2	1	2	3	2

3/2/1 Indicates Strength Of Correlation, 3 – High, 2- Medium, 1- Low

Category	Basic Sciences	Engg.Science	Humanities & social Science	Program Core	Program Elective	Open Elective	Practical/Proj ect	Internships/ Technical Skills	Soft Skills
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Code. No	Course Title	L	T	P	C
HMCH18GE6	Nano Chemistry	3	0	0	2

OBJECTIVES

- To acquire knowledge about nanochemistry.
- To learn the synthesis of nanomaterials, characterization and applications.

UNIT-I: BASIC CONCEPTS OF NANOCHEMISTRY **6hrs**

Introduction to nanoscience and nanotechnology, discussion on various phenomenon at nano- scale, such as size, shape, surface, surface energy, surface stabilization, characteristic length, self-assembly, defects, size quantization, surface plasmon, conductivity, tunneling, magnetism, defects.

UNIT-II: SYNTHESIS OF NANOMATERIALS **6hrs**

Basics of nanofabrication method: top-down, bottom-up approaches, gas phase, liquid phase, solid phase synthesis, self-assembly, templated synthesis, sol-gel, electrodepostion, fundamentals of nanoparticle formation, thermodynamic approach, supersaturation, nucleation, growth, homo vs hetero nucleation. Synthesis of nanoparticles: metallic, semiconducting, quantum dots, oxides, hybrids, micelles and microemulsion as templates for synthesis. 0D, 1D and 2D nanoparticles, core-shell nanoparticles, special nanoparticles, shaped nanoparticles.

UNIT-III: CHARACTERISATION TECHNIQUES **6hrs**

Discussion on various techniques available for characterizing the nanomaterials for their size, shape, morphology, crystalline phase, oxidation states, textural properties (surface area, pore volume, pore size), thermal stability, light absorption and band gap.Scanning electron microscope (SEM) &Transmission electron microscope (TEM), X-ray powder diffraction (XRD) & X-ray photoelectron spectroscope (XPS), Scanning tunnelling microscope (STM) and Atomic force microscope (AFM). Thermal analysis, N_2 sorption techniques for textural properties of the material solid state NMR for characterizing functionalizedmaterials.

UNIT-IV: CARBON CLUSTERS AND NANOSTRUCTURES **6hrs**

Bonding in carbon, new carbon structures, carbon clusters, discovery of C60, alkali doped C60,superconductivity in C60, larger and smaller fullerenes, carbon nanotubes: synthesis, single walled carbon nanotubes, structure and characterization, mechanism of formation, chemically modified carbon nanotubes, doping, functionalizing nanotubes, application of carbon nanotubes, nanowires, synthetic strategies, gas phase and solution phase growth, growth control, properties.

UNIT -V: NANOMATERIALS FOR CATALYSIS **6hrs**

Nanocatalysis: fundamentals, homogeneous vs heterogeneous catalysis, effect of surface area, effect of particle size, shape and morphology, effect of composition, bimetallic system etc, nanomaterials for photo- catalysis [dye degradation, water splitting, organic transformations, plasmon assisted photo-catalysis, bandgap tuning, etc], nanomaterials for CO_2 capture and conversion.

REFERENCE BOOKS

1. C. N. R.Rao, A. Muller and A. K. Cheetam, (Eds) (2004):
2. The Chemistry of Nanomaterials, Vol.1, and 2, Wiley – VCH, Weinheim.

3. C. P. Poole, and Jr. F. J. Owens, Introduction to Nanotechnology, Wiley Interscience, NewJersey. 2003.
4. K. J. Klabunde, Nanoscale materials in Chemistry, Wiley- Interscience, New York, 2001.
5. T. Pradeep, Nano: The Essentials in Understanding Nanoscience and Nanotechnology, TataMcGraw Hill, New Delhi, 2007.
6. T. Tang and P. Sheng, Nano Science and Technology – Novel Structures andPhenomena, Taylor & Francis, New York, 2004.

U. Heiz, and U. Landman, Nanocatalysis, Springer, New York, 2006.