NOIDA INTERNATIONAL UNIVERSITY

GREATER NOIDA

CHOICE BASED COURSE SYLLABUS

Effective from the Session: 2019-2020

MSc. CHEMISTRY

(ALL SEMESTERS)

Department Of Chemistry

SCHOOL OF SCIENCES

Aims of Master's degree programme in Chemistry

The broad aims of Master's degree programme in Chemistry are:

The aim of b Master's degree programme in chemistry is intended to provide:

(i) Broad and balance knowledge in chemistry in addition to understanding of key chemical concepts, principles and theories.

(ii) To develop students' ability and skill to acquire expertise over solving both theoretical and applied chemistry problems.

(iii) To provide knowledge and skill to the students' thus enabling them to undertake further studies in chemistry in related areas or multidisciplinary areas that can be helpful for self-employment/entrepreneurship.

(iv) To provide an environment that ensures cognitive development of students in a holistic manner. A complete dialogue about chemistry, chemical equations and its significance is fostered in this framework, rather than mere theoretical aspects.

(v) To provide the latest subject matter, both theoretical as well as practical, such a way to foster their core competency and discovery learning. A chemistry post graduate as envisioned in this framework would be sufficiently competent in the field to undertake further discipline-specific studies, as well as to begin domain-related employment.

(vi) To mould a responsible citizen who is aware of most basic domain-independent knowledge, including critical thinking and communication.

(vii) To enable the graduate prepare for national as well as international competitive examinations, especially UGC-CSIR NET and UPSC Civil Services Examination.

Program Learning Outcomes

The student graduating with the Degree M.Sc. Chemistry should be able toacquire

 Core competency: Students will acquire core competency in the subject Chemistry, and in allied subject areas.

(i). Systematic and coherent understanding of the fundamental concepts in Physical chemistry, Organic Chemistry, Inorganic Chemistry, Analytical Chemistry, Industrial Chemistry and all other related allied chemistry subjects.

(ii).Students will be able to use the evidence based comparative chemistry approach to explain the chemical synthesis and analysis.

(iii).The students will be able to understand the characterization of materials.

(iv). Students will be able to understand the basic principle of equipment's, instruments used in the chemistry laboratory.

(v).Students will be able to demonstrate the experimental techniques and methods of their area of specialization in Chemistry.

(vi). ***Disciplinary knowledge and skill***: A graduate student is expected to be capable of demonstrating comprehensive knowledge and understanding of both theoretical and experimental/applied chemistry knowledge in various fields of interest like Analytical Chemistry, Physical Chemistry, Inorganic Chemistry, Organic Chemistry, Material Chemistry, etc. Further, the student will be capable of using of advanced instruments and related soft-wares for in-depth characterization of materials/chemical analysis and separation technology.

(vii) ***Skilled communicator***: The course curriculum incorporates basics and advanced training in order to make a graduate student capable of expressing the subject through technical writing as well as through oral presentation.

(viii) ***Critical thinker and problem solver***: The course curriculum also includes components that can be helpful to graduate students to develop critical thinking ability by way of solving problems/numerical using basic chemistry knowledge and concepts.
(ix) ***Sense of inquiry***: It is expected that the course curriculum will develop an inquisitive characteristics among the students through appropriate questions, planning and reporting experimental investigation.
(x) ***Team player***: The course curriculum has been designed to provide opportunity to act as team player by contributing in laboratory, field based situation and industry.
(xi) ***Skilled project manager***: The course curriculum has been designed in such a manner as to enabling a graduate student to become a skilled project manager by acquiring knowledge about chemistry project management, writing, planning, study of ethical standards and rules and regulations pertaining to scientific project operation.
(xii) ***Digitally literate***: The course curriculum has been so designed to impart a good working knowledge in understanding and carrying out data analysis, use of library search tools, and use of chemical simulation software and related computational work.
(xiii) ***Ethical awareness/reasoning***: A graduate student requires to understand and develop ethical awareness/reasoning which the course curriculum adequately provide.
(xiv) ***Lifelong learner***: The course curriculum is designed to inculcate a habit of learning continuously through use of advanced ICT technique and other available techniques/books/journals for personal academic growth as well as for increasing employability opportunity.

NOIDA INTERNATIONAL UNIVERSITY

SCHOOL OF SCIENCES
Study & Evaluation Scheme for M.Sc. Chemistry
1st Year, SEMESTER-I

S.No	Course Code	Subject	Period			Evaluation Scheme				Subject Total	Credit
						Sessional Exam			External Exam		
			L	T	P	CA	TA	Total			
1	STPC-101	Physical Chemistry-I	4	0	0	20	20	40	60	100	4
2	STPC-102	Inorganic Chemistry-I	4	0	0	20	20	40	60	100	4
3	STPC-103	Organic Chemistry-I	4	0	0	20	20	40	60	100	4
4	STPC-104	Green Chemistry	4	0	0	20	20	40	60	100	4
Practical											
5	SPPC-101	Physical Chemistry-I Lab	0	0	2			25	25	50	2
6	SPPC-102	Inorganic Chemistry-I Lab	0	0	2			25	25	50	2
7	SPPC-103	Organic Chemistry-I Lab	0	0	2			25	25	50	2
8	SPPC-104	Green Chemistry Lab	0	0	2			25	25	50	2
Total										600	24

NOIDA INTERNATIONAL UNIVERSITY
SCHOOL OF SCIENCES
Study & Evaluation Scheme for M.Sc. Chemistry
1st Year,
SEMESTER-II

S.No	Course Code	Subject	Period			Evaluation Scheme				Subject Total	Credit
						Sessional Exam			External Exam		
			L	T	P	CA	TA	Total			
1	STPC-201	Physical Chemistry-II	4	0	0	20	20	40	60	100	4
2	STPC-202	Inorganic Chemistry-II	4	0	0	20	20	40	60	100	4
3	STPC-203	Organic Chemistry-II	4	0	0	20	20	40	60	100	4
4	STPC-204	Applied Nanomaterials	4	0	0	20	20	40	60	100	4
Practical											
5	SPPC-201	Physical Chemistry-II Lab	0	0	2			25	25	50	2
6	SPPC-202	Inorganic Chemistry-II Lab	0	0	2			25	25	50	2
7	SPPC-203	Organic Chemistry-II Lab	0	0	2			25	25	50	2
8	SPPC-204	Synthesis of Nanomaterials Lab	0	0	2			25	25	50	2
Total										**600**	**24**

NOIDA INTERNATIONAL UNIVERSITY
SCHOOL OF SCIENCES
Study & Evaluation Scheme for M.Sc. Chemistry
II Year
SEMESTER-III

S.No	Course Code	Subject	Period			Evaluation Scheme				Subject Total	Credit
						Sessional Exam			External Exam		
			L	T	P	CA	TA	Total			
1	STPC-301	Physical Chemistry-III	4	0	0	20	20	40	60	100	4
2	STPC-302	Synthetic Organic Chemistry	4	0	0	20	20	40	60	100	4
3	STPC-303	Drug Synthesis	4	0	0	20	20	40	60	100	4
4	STPC-304	Industrial Chemistry	4	0	0	20	20	40	60	100	4
Practical											
5	SPPC-301	Physical Chemistry-III Lab	0	0	2			25	25	50	2
6	SPPC-302	Synthetic Organic Chemistry Lab	0	0	2			25	25	50	2
7	SPPC-303	Drug Synthesis Lab	0	0	2			25	25	50	2
8	SPPC-304	Industrial Chemistry Lab	0	0	2			25	25	50	2
Total										**600**	**24**

Study & Evaluation Scheme for M.Sc. Chemistry
II Year
SEMESTER-IV

S.No	Course Code	Subject	Period			Evaluation Scheme				Subject Total	Credit
						Sessional Exam			External Exam		
			L	T	P	CA	TA	Total			
1	STPC-401	Polymers and Plastics	4	0	0	20	20	40	60	100	4
2	STPC-402	Intellectual Property Rights	4	0	0	20	20	40	60	100	4
3	SPPC 403	Dissertation/Project								200	12
Total										**400**	**20**

OVER ALL SCHEME

S. No.	SEMESTER	Theory Total	Practical Total	Subject Total	Total Credit
1	I	400	150	600	24
2	II	400	150	600	24
3	III	400	150	600	24
4	IV Dissertation/ Project	200 (Theory) +200 (Project)	200 (Dissertation + presentation + viva)	400	20
			Grand Total	**2200**	**92**

SEMESTER-I

Course Code : STPC-101 **Course Name : Physical Chemistry**

Course Credit Hour : 4hr **Total Contact Hour :** 60hr

Course Objective :

- This course is aimed to provide the students with a solid understanding of all the fundamental concepts physical chemistry necessary for the study of the more advanced or specialized courses. General idea about the heat flow, work done, enthalpy. Concept of system and types. Brief knowledge of laws of thermodynamics, kinetics and molecular dynamics. Reactions and their kinetics awareness. Application based learning of the subject.

Course Description :

- The use of simple models for predictive understanding of physical phenomena associated to chemical thermodynamics and kinetics. To relate the thermodynamic changes and its relevance in our daily lives and processes. Discussion on the improvement of technology by increasing the heat efficiency.

Course Contents : L-4 T-0 P-2

TEHRMODYNAMICS

Unit-I First law of Thermodynamics: Heat, Work, & Conservation of energy – The basic concepts, the first law, infinitesimal changes, mechanical work, work of compression & expansion, free expansion, Expansion against constant pressure, reversible expansion, Heat:- heat capacity, enthalpy. State functions & differentials – state functions, Exact & Inexact differential, changes in internal energy, temperature dependence of the internal energy, Temperature dependence of the enthalpy.

Unit-II Second law of Thermodynamics: Measuring the dispersal the entropy, The second law, the definition of entropy, the entropy changes in the system, natural events. Entropy changes in the universe – The enthalpy change when a system is heated, Entropy changes in surroundings, the entropy of phase transition, the entropy of irreversible changes.

Unit-III Combining First & Second Law: One way of developing the fundamental equations Properties of Gibbs function, The temperature dependence of the Gibbs functions, The pressure dependence of the Gibbs functions, The Chemical potential of a perfect gas, The open system & changes of composition.

CHEMICAL KINETICS

Unit-IV Chemical equilibria: Simple reactions, The temperature dependence of reaction rates, Reaction approaching equilibrium consecutive reactions, The steady state approximations, Pre-equilibira, Unimolecular reactions, Enzyme catalysis – Michaelis

Menton mechanism, Lineweaver and Eadie plots, The kinetics of complex reaction, Chain reactions, the structure of chain reactions Explosions, - Fast reactions, flash photolysis, Flow technique, relaxation methods,

Unit-V Molecular reaction dynamics: Collision theory basic calculation, the steric requirement, Diffusion controlled reactions- Classes of reactions, diffusion & reaction, the details of diffusion, Activated complex. The reaction co – ordinate & transition state, the formulation & decay of the activated complex, How to use the Eyring equation. Thermodynamic aspect, reaction between ions, Dynamics of molecular collisions,

SPPC-101: Lab Experiments:

1. Estimate the amount of magnesium present in the whole of the given solution. You are provided with the crystals of magnesium sulphate.
2. Estimate the amount of calcium present in the whole of the given solution. You provided with the crystals of calcium sulphate.
3. Estimate the amount of zinc present in the whole of the given solution. You provided with the crystals of zinc sulphate.
4. To determine the amount of Ni^{++} in the given sample of nickel ammonkum sulphate using 0.1 M EDTA solution and murexide as an indicator.
5. To estimate the amount of sodium nitrite present in the give sample of solution using 0.1 N $KMnO_4$
6. To estimate the amount of cerium and ferrous using cerium sulphate and ferrous ammonium sulphate

Course Learning Outcomes (CLOs) :

CLO-1: To gain better understanding of the heat changes, internal energy, enthalpy and heat capacity.

CLO-2: To understand the mathematical relations of different physical quantity.

CLO-3: To develop the better understanding of entropy changes and heat efficiency concept.

CLO-4: To learn reactions, their dependence and kinetics.

CLO-5: To understand the molecular reaction dynamics study with the introduction of collision theory, activated complex and dynamics of molecular collisions.

Text books :

1. Physical Chemistry - P.W. Atkin, ELBS fourth edition.
2. Physical Chemistry – R.A. Alberty, R.I. Bilby, Johy Wiley – 1995
3. Physical Chemistry – G.M. Barrow, Tata Mc – Graw Hill – 1988
4. Quantum Chemistry, - I . Levine, Fifth edition, Prentice Hall- 1999

Reference books :

1. Essentials of Physical chemistry - Bahl and Tuli, S. Chand- 2012
2. Mark Zemansky (Author), Richard Dittman, Heat and Thermodynamics – SIE 8th Edition Paperback – 1 July 2017, ISBN-13: 978-0070700352
3. Yunus A. Cengel, Michael A. Boles, Mehmet Kanoglu, Thermodynamics - An Engineering Approach, 9th Edition Paperback – 26 June 2019, ISBN-13 : 978-9353165741

Online links for study & reference materials :

1. https://courses.lumenlearning.com

2. https://courses.lumenlearning.com3.

3. https://www2.estrellamountain.edu

4. https://www.siyavula.com

5. https://www.britannica.com/science/chemical-equilibrium

6. .https://www.jstor.org/stable/43420629

Course Code : STPC-102 **Course Name: INORGANIC CHEMISTRY-I**
Course Credit Hour : 4hr **Total Contact Hour : 60hr**

Course Objective :

- After completion of the course, the learner shall be able to understand the various types of isomerism which can occur in coordination complexes, the systematic names of simple coordination compounds.

Course Description :

- The students should be able to explain what is meant by the Spectrochemical Series and list the approximate order of common ligands, molecular orbital theory, Crystal Symmetry. The students should be able to give appropriate definitions of the terms inert and labile and state which d-electron configurations are associated with inertness. Solutions in non-aqueous Media, application of crown ethers, Allotropes of Carbon, synthesis, properties, uses, structure & bonding with respect to VSEPR.

Course Contents : L-4 T-0 P-2

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Unit-I Molecular symmetry and symmetry groups: Symmetry elements and operations. Symmetry planes, reflections, inversion centre, proper/ improper axes of rotation, products of symmetry operations, equivalent symmetry elements and atoms, symmetry elements and optical isomerism, symmetry point groups, classes of symmetry operations, classification of molecular point groups.

Unit-II Molecular Orbital Theory: Transformation properties of atomic orbital, MO's for Sigma bonding ABn molecules, tetrahedral AB4 case.

Unit-III Crystallographic Symmetry: Unit cell, screw axis, glide plane on unit cell, crystal lattice, space lattice, stereographic projectors. Examples on crystallographic planes, cubic planes, Miller indices, Bravais lattices.

Unit-IV Alkali & alkaline earth metals
Solutions in non-aqueous Media. Application of crown ethers in extraction of alkali & alkaline earth metals.

Unit-V: Carbon, Nitrogen, Oxygen, Halogen groups and Noble gases
Allotropes of Carbon, C60 and compounds (fullerenes), Nitrogen activation, Boron nitride, Interhalogens, Pseudohalogen, synthesis, properties &applications, structure, oxyacids&oxoanions of Hallogens, Nobel gases synthesis, properties, uses, structure & bonding with respect to VSEPR.

SPPC-102: Lab Experiments:

1. Estimate the amount of magnesium present in the whole of the given solution. You are provided with the crystals of magnesium sulphate.
2. Estimate the amount of calcium present in the whole of the given solution. You provided with the crystals of calcium sulphate.
3. Estimate the amount of zinc present in the whole of the given solution. You provided with the crystals of zinc sulphate.
4. To determine the amount of Ni^{++} in the given sample of nickel ammonkum sulphate using 0.1 M EDTA solution and murexide as an indicator.
5. To estimate the amount of sodium nitrite present in the give sample of solution using 0.1 N $KMnO_4$
6. To estimate the amount of cerium and ferrous using cerium sulphate and ferrous ammonium sulphate

Course Learning Outcomes (CLOs) :

CLO-1 : To learn the various characteristics of Symmetry elements and operations. Symmetry planes, reflections, inversion centre, proper/ improper axes of rotation.

CLO-2 : To learn the various characteristics of solutions in non-aqueous Media

CLO-3 : To learn the concept of molecular orbital theory.

CLO-4 : To learn the various application of crown ethers,

CLO-5 : To learn the allotropes of Carbon, synthesis, properties, uses, structure & bonding with respect to VSEPR.

Text books :

1. Chemical application and group Theory: F.A. Cotton, 3rd edition (1999)
2. Advanced Inorganic Chemistry: F.A. Cotton, G. Wilkinson, C.A. Murillo, M.Bochmann 6th Edn. (2003)
3. Symmetry in Chemistry: H. Jaffe' and M. Orchin (2002)
4. Group theory and its chemical application: P.K. Bhattacharya, 2nd edn. (1989)
5. Inorganic Chemistry: Shriver and Atkins, 4th edn. (2003) Oxford

Reference books :

1. Lee., J. D.(2010),A new Concise Inorganic Chemistry, Pearson Education.
2. Huheey, J.E.; Keiter, E.; Keiter, R. (2009),Inorganic Chemistry: Principles of Structure and Reactivity, Pearson Publication.
3. Atkins, P.W.; Overton, T.L.; Rourke, J.P.; Weller, M.T.; Armstrong, F.A.(2010),Shriver and Atkin's Inorganic Chemistry, Oxford
4. Sykes, P.(2005), A Guide Book to Mechanism in Organic Chemistry, Orient Longman.

Online links for study & reference materials :

Course Code: STPC-103 **Course Name: ORGANIC CHEMISTRY-I**
Course Credit Hour : 4hr **Total Contact Hour : 60hr**

Course Objective :

- After completion of the course, the learner shall be able to understand the mechanisms involved in aliphatic nucleophillic substitution reactions, topicity of ligands, the concept of aromaticity and Mechanistic and Stereo chemical aspects of addition reactions involving electrophiles, nucleophiles and Free radicals.

Course Description :

- This course summary shall indicate the specific key topics of the aromaticity, aromaticity in Benzenoid and non – Benzenoid compounds, SN2, SN1, mixed (SN1 and SN2) and SNi, neighboring group mechanism, Mechanistic and Stereo chemical aspects of addition reactions involving electrophiles, nucleophiles and Free radicals, Regio and Chemo selectivity, Orientation and reactivity, E2, E1, E1cb Mechanisms, Orientation, stereochemistry in elimination, reactivity effect of structure attacking and leaving groups, competition between substitution & elimination.

Course Contents : L-4 T-0 P-2

Unit-I: Nature of Bonding in Organic Molecules: Delocalized chemical bonding – Conjugation, cross conjugation, resonance, hyper conjugation, tautomerism, inductive Resonance effects. Acidity and Basicity. Introduction to aromaticity in Benzenoid and non – Benzenoid compounds, alternant and non-alternant hydrocarbon, Huckel Rule.

Unit-II Aliphatic Nucleophilic Substitution: The SN2, SN1, mixed (SN1 and SN2) and SNi mechanism. The neighboring group mechanism, The Neighbouring group participation by π & σ bonds, anchimeric assistance, classical and non classical carbocations, phenonium ions, norbornylsyste, carbocation rearrangements in neighboring group participation.

Unit-III Addition to Carbon – Carbon Multiple bonds: Mechanistic and Stereo chemical aspects of addition reactions involving electrophiles, nucleophiles and Free radicals, Regio and Chemo selectivity, Orientation and reactivity, Michael reaction.

Unit-IV Aromatic Electrophilic Substitution: The arenium ion mechanism, orientation and reactivity, energy profile diagram, The ortho/ para ratio ipso attack, orientation in other ring systems, Naphthalene, Anthracene, Six and five membered heterocycles, Diazonium coupling Vilsmeier reaction, Gattermann – Koch reaction, etc.

Unit-V Elimination reactions: E2, E1, E1cb Mechanisms, Orientation, stereochemistry in elimination, reactivity effect of structure attacking and leaving groups, competition between substitution & elimination , syn eliminations.

SPPC-103: Lab Experiments:

1. To prepare p-nitro benzoic acid from p-nitro toluene.
2. To prepare anthracene to anthraquinone
3. To prepare benzhydrol from benzophenone
4. To prepare 1,2,3,4-Tetrahydrocarbazole from cyclohexanone
5. To prepare methyl orange from sulphanilic acid.
6. To prepare benzilic acid from benzoin.

Course Learning Outcomes (CLOs) :

CLO-1 : To learn the aromaticity, aromaticity in Benzenoid and non – Benzenoid compounds

CLO-2 : To understand the SN2, SN1, mixed (SN1 and SN2) and SNi, neighboring group mechanism

CLO-3 : To learn the mechanistic and stereo chemical aspects of addition reactions involving electrophiles, nucleophiles and Free radicals, Regio and Chemo selectivity

CLO-4 : To understand the orientation and reactivity, E2, E1, E1cb Mechanisms, Orientation, stereochemistry in elimination, reactivity effect of structure attacking and leaving groups, competition between substitution & elimination.

Text books :

1. Eliel, E. L. (2000), Stereochemistry of Carbon Compounds, Tata McGraw Hill.
2. Morrison, R. N.; Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
3. Bahl, A; Bahl, B. S. (2012), Advanced Organic Chemistry, S. Chand.
4. Finar, I. L. Organic Chemistry (Volume 1 & 2), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).

Reference books :

5. Pine S. H. Organic Chemistry, Fifth Edition, McGraw Hill, (2007)
6. F. A. Carey, Organic Chemistry, Seventh Edition, Tata McGraw Hill (2008).
7. J. Clayden, N. Greeves, S. Warren, Organic Chemistry, 2nd Ed., (2012), Oxford
8. Universitiy Press.
9. F. A. Carey, R. J. Sundberg, Advanced Organic Chemistry, Part A: Structure and mechanism, Kluwer Academic Publisher, (2000).

Online links for study & reference materials :

1. http://www.freebookcentre.net/Chemistry/Organic-Chemistry-Books.html
2. https://chem.ucr.edu/curricular-materials/textbook
3. https://www2.chemistry.msu.edu/faculty/reusch/VirtTxtJml/intro1.htm
4.https://chemistry.com.pk/free-download-chemistry-books/
5.https://bookboon.com › chemistry-ebooks
6. **https://bookauthority.org/books/best-industrial-chemistry-books**

Course Code : STPC-104 Course Name: GREEN CHEMISTRY
Course Credit Hour : 4hr Total Contact Hour : 60hr

Course Objective :

- Today's society is moving towards becoming more and more environmentally conscious. There is rising concern of environmental pollution, depleting resources,

climate change, ozone depletion, heaps and heaps of landfills piling up, legislation which is getting stringent with strict environmental laws, rising cost of waste deposits and so on. We are faced with a challenge to work towards sustainable practices. Green chemistry has arisen from these concerns. It is not a new branch of chemistry but the way chemistry should be practiced. Innovations and applications of green chemistry in education has helped companies not only gain environmental benefits but at the same time achieve economic and societal goals also. This is possible because these undergraduate students are ultimate scientific community of tomorrow.

Course Description :

- Understand the twelve principles of green chemistry and will build the basic understanding of toxicity, hazard and risk of chemical substances. Understand stoichiometric calculations and relate them to green chemistry metrics. They will learn about atom economy and how it is different from percentage yield. Learn to design safer chemical, products and processes that are less toxic, than current alternatives. Importance led reactions in various green solvents. Green chemistry is a way to boost profits, increase productivity and ensure sustainability with absolute zero waste. Success stories and real world cases also motivate them to practice green chemistry.

Course Contents : L-4 T-0 P-2

Unit l Introduction to Green Chemistry

What is Green Chemistry? Need for Green Chemistry. Goals of Green Chemistry. Limitations/Obstacles in the pursuit of the goals of Green Chemistry.

Unit II Principles of Green Chemistry and Designing a Chemical synthesis

Twelve principles of Green Chemistry with their explanations and examples; Designing a Green Synthesis using these principles; Prevention of Waste/byproducts; maximum incorporation of the materials used in the process into the final products (Atom Economy); prevention/minimization of hazardous/toxic products; designing safer chemicals – different basic approaches to do so; selection of appropriate auxiliary substances (solvents, separation agents), green solvents, solventless processes, immobilized solvents and ionic liquids; energy requirements for reactions - use of microwaves, ultrasonic energy; selection of starting materials; avoidance of unnecessary derivatization – careful use of blocking/protectinggroups; use of catalytic reagents (wherever possible) in preference to stoichiometric reagents; designing of biodegradable products; prevention of chemical accidents; strengthening/development of analytical techniques to prevent and minimize the generation of hazardous substances in chemical processes.

Unit III Examples of Green Synthesis/Reactions

1 Green Synthesis of the following compounds: adipic acid, catechol, BHT, methyl methacrylate, urethane, aromatic amines (4-aminodiphenylamine), benzyl bromide, acetaldehyde, disodium iminodiacetate (alternative to strecker synthesis), citral, ibuprofen, paracetamol, turtural. (furfural)

2 Microwave assisted reactions in water: Hofmann Elimination, Hydrolysis (of benzyl chloride, benzamide, n-phenyl benzamide, methylbenzoate to benzole acid), Oxidation (of toluene, alcohols). Microwave assisted reactions in organic solvents: Esterification, Fries rearrangement, Orthoester Claisen Rearrangement, Diels Alder Reaction, Decarboxylation. Microwave assisted solid state reactions: Deacetylation, Deprotection. Saponification of esters, Alkylation of reactive methylene compounds, reductions, synthesis of nitriles from aldehydes; anhydrides from dicarboxylic acid; pyrimidine and pyridine derivatives; 1,2-dihydrotriazine derivatives; benzimidazoles.

Unit IV

1 Ultrasound assisted reactions: Esterification, saponification, substitution reactions, Alkylations, oxidation, reduction, coupling reaction, Cannizaro reaction, Strecker synthesis, Reformatsky reaction.

2 Selective methylation of active methylene group using dimethylcarbonate: Solid-state polymerization of amorphous polymers using diphenylcarbonate; Use of "Clayan", a non-metallic oxidative reagent for various reactions; Free Radical Bromination; Role of Tellurium in Organic Syntheses; Biocatalysis in Organic Syntheses.

Unit V Future Trends in Green Chemistry

Oxidation reagents and catalysts; Biomimetic, multifunctional reagents; Combinatorial green chemistry; Proliferation of solventless reactions; oncovalent derivatization; Green chemistry in sustainable development.

Course Learning Outcomes (CLOs) :

After finishing the course student will be able to:

CLO-1: To understand the principles of green chemistry and end-of-pipe method

CLO-2: To understand and can plan green solutions for industrial production of Petroleum and petrochemicals, Surfactants, Organic and inorganic chemicals

CLO-3: To provide green solutions for chemical energy storage, Energy carriers and alternative fuels including electrofuels and hydrogen

CLO-4: To present examples of successful green technologies

Text books :

1. V.K. Ahluwalia & M.R. Kidwai: New Trends in Green Chemistry, Anamalaya Publishers, 1st Edition, ISBN 978-94-015-7102-9
2. P.T. Anastes & J.K. Warmer: Oxford Green Chemistry- Theory and Practical, University Press (1998). ISBN: 9780198506980

3. A.S. Matlack: Introduction to Green Chemistry, Marcel Deckkar, (2001).

4. M.C. Cann & M.E. Connely: Real-World cases in Green Chemistry, American Chemical Society, Washington (2000).
5. M.A. Ryan & M. Tinnesand, Introduction to Green Chemistry, American Chemical Society, Washington (2002).

Reference books :

1. Lancaster, M.(2016),Green Chemistry An Introductory Text.2nd Edition, RSC Publishing.
2. Dr. Indu Tucker Sidhwani, Rakesh K. Sharma **An Introductory Text on Green Chemistry,** 1st edition, ISBN-10 : 812655407X
3. Paul T. Anastas, John Charles Warner, Green Chemistry Theory and Practice, 1st Edition, ISBN:9780198506980, 0198506988
4. R. A. Sheldon, Isabella Arends, Ulf Hanefeld , Green Chemistry and Catalysis, Wiley, 1st Edition, ISBN:9783527611010, 3527611010

Online links for study & reference materials :

1. https://www.acs.org/content/dam/acsorg/greenchemistry/education/summerschool/Kirchhoff%20Green%20Chemistry%20Principles%20and%20Practice2.pdf
2. https://oregonstate.edu/instruct/ch390/lessons/media/lesson1.pdf
3. faculty.swosu.edu/tim.hubin/share/Microwave%20Synthesis.pdf
4. https://oatao.univ-toulouse.fr/10066/1/Lesage_10066.pdf

SPPC-104- List of Laboratory Experiments

1. Pechmann Condensation For Coumarin Synthesis
2. Electrophilic Aromatic Substitution Reaction-I
3. Electrophilic Aromatic Substitution Reaction-II (Bromination Of Acetanilide)
4. Green Photochemical Reaction ((Photoreduction Of Benzophenone To Benzopinacol)
5. Pinacol Pinacolone Rearrangement Reaction-I ((Preparation Of Benzopinacolone)
6. Rearrangement Reaction - II ((Rearrangement Of Diazoaminobenzene To p-Aminoazobenzene)
7. Radical Coupling Reaction ((Preparation Of 1, 1-Bis-2-Naphthol)
8. Three Component Coupling (Synthesis Of Dihydropyrimidinone)

SEMESTER – II

Course Code : STPC-201 Course Name: PHYSICAL CHEMISTRY-II
Course Credit Hour : 4hr Total Contact Hour : 60hr

Course Objective :

- After completion of the course, the learner shall be able to understand the course exposes students to the laws of spectroscopy and selection rules governing the possible transitions in the different regions of the electromagnetic spectra. Thermal and electroanalytical methods of analysis are also dealt with. Students are exposed to important separation methods like solvent extraction and chromatography. The practicals expose students to latest instrumentation and they learn to detect analytes in a mixture.

Course Description :

- This course summary shall indicate the specific key topics of the perform experiment with accuracy and precision. Develop methods of analysis for different samples independently. Test contaminated water samples. Understand basic principle of instrument like Flame Photometer, UV-vis spectrophotometer. Learn separation of analytes by chromatography. Apply knowledge of geometrical isomers and keto-enol tautomers to analysis. Estimate macronutrients using Flame photometry. Basic concepts of nuclear chemistry.

Course Contents : L-4 T-0 P-2

MOLECULAR SPECROSCOPY

Unit-I Introduction: Width and intensity of spectral transitions, Fourier transform, microwave spectroscopy, rotation spectra of di – and poly- atomic molecules,

Unit-II Infrared spectroscopy: Harmonic and anharmonic oscillator, vibrational spectra of di – and poly atomic molecules, coarse and fine structure, Nuclear spin effect.

Unit-III Raman Spectroscopy: Introduction, Rotational Raman spectra, Vibrational Raman Spectra, polarization of light and Raman effect, structure elucidation from combined Raman and IR spectroscopy and applications.

NUCLEAR & RADIATION CHEMISTRY

Unit-1V Radio Chemistry: Type of radioactive decay, Decay Kinetics, Detection &

measurement of radiation (G.M. & Scintillation counter)

Unit-V Nuclear Reactor: The fission energy, The Natural uranium reactor, the four factor formula- The reproduction factor K, the classification of reactor. Reactor power, Critical size of thermal reactor, excess reactivity & control, the Breeder reactor, The Indians nuclear energy programme, Reprocessing of spent fuel: Recovery of Uranium & Plutonium, Nuclear waste management.

SPPC-201 - Lab Experiments:

1. To estimate the amount of Nickel present in the whole of given solution.
2. To estimate the amount of copper present in the whole of given solution.
3. Qualitative analysis of inorganic mixture
4. Qualitative analysis of inorganic mixture
5. Qualitative analysis of inorganic mixture
6. Qualitative analysis of inorganic mixture

Course Learning Outcomes (CLOs) :

CLO-1 : To understand the spectral transitions and rotation spectra of di – and poly-atomic molecules

CLO-2 : To understand the basic principles of Infrared spectroscopy of vibrational spectra, di – and poly- atomic molecules, nuclear spin effect and applications in structure elucidation.
CLO-3 : To understand the basic principles of Raman spectroscopy of polarization of light and Raman effect applications in structure elucidation
CLO-4 : To learn chemistry of radio activity, Type of radioactive decay, Decay Kinetics, Detection & measurement of radiation.
CLO-5 : To learn chemistry of nuclear reactors, classification, type of reactors, Nuclear waste management.

Text books :

1. Willard, H.H.(1988),Instrumental Methods of Analysis, 7th Edition, Wardsworth Publishing Company.
2. Christian, G.D.(2004),Analytical Chemistry, 6th Edition, John Wiley & Sons, New York.
3. Harris, D. C.(2007),Quantitative Chemical Analysis,6th Edition, Freeman.
4. Elements of Nuclear chemistry – H.J. Arnikar, fourth edition wileyEstern Ltd.
5. Source book of atomic energy – S. Glasstanc, D. Van Norton company.
6. Chemical applications of radioisotopes – H.J. M. Brown Buffer & Jammer Ltd.
7. Fundamentals of molecular spectroscopy: C.N. Banewell and E.Mc. Cash (Fourth

edition).

Reference books :

8. Khopkar, S.M. (2008), Basic Concepts of Analytical Chemistry, New Age International Publisher.
9. Skoog, D.A.; Holler F.J.; Nieman, T.A. (2005), Principles of Instrumental Analysis, Thomson Asia Pvt. Ltd.

Online links for study & reference materials :

1. https://www2.chemistry.msu.edu.
2. https://chem.libretexts.org.
3. https://chemistry.tutorvista.com/inorganic-chemistry/oxidation-states.html.
4. http://www.uou.ac.in/sites/default/files/slm/BSCCH-201.pdf
5. https://www.bing.com/videos/search?q=liquid+states+of+matter&&view=detail&mid=888BE9D5C1C2757422F9888BE9D5C1C2757422F9&&FORM=VRDGAR&ru=%2Fvideos%2Fsearch%3Fq%3Dliquid%2Bstates%2Bof%2Bmatter%26qpvt%3Dliquid%2Bstates%2Bof%2Bmatter%26FORM%3DVDRE

Course Code : STPC-202 Course Name: INORGANIC CHEMISTRY-II
Course Credit Hour : 4hr Total Contact Hour : 60hr

Course Objective :

- To get significant knowledge on molecular symmetry to understand its role in chemistry. To describe bonding and anti-bonding molecular orbitals. To describe three-dimensional periodicity of crystal structure; define relationship between diffraction pattern and crystal structure. Explain the properties and extraction of alkali metals and alkaline earth metals. List the allotropes of carbon, physical and chemical properties of halogens, noble gases.

Course Description :

- Symmetry operations, equivalent symmetry elements and atoms, optical isomerism, symmetry point groups, sigma bonding for tetrahedral molecules, symmetry elements of molecules and simple crystal structures, relationship between diffraction pattern and crystal structure; describe and explain basic structural types, alkali and alkaline earth metals, allotropes of carbon, halogens and noble gases, their properties structure and bonding.

Course Contents : L-4 T-0 P-2

Unit-I Chemistry of non – Transition elements:

Polymorphism in carbon, Synthesis, properties and structure of boranes, carboranes, silicates, carbides, phosphazenes, sulphur – nitrogen compounds, peroxo compounds of boron, carbon, sulphur.

Unit-II Studies and applications of Lanthanides and Actinides:

Transition metals – general characteristics – metallic character – oxidation states – size – density – melting and boiling points – ionization energy – colour – magnetic properties – reducing properties – catalytic properties – Non stoichiometric compounds – complex formation – alloy formation – difference between first row and other two rows.

Lanthanides – Electronic configuration and general characteristics – occurrence of lanthanides – separation by ion exchange method – lanthanide contraction.

Actinides – Electronic configuration and general characteristics – comparison with lanthanides. Organometallic chemistry applications of lanthanide and actinide compounds in Industries.

Unit-III Metallurgy

Occurrence of metals based on standard electrode potential – concentration of ores– calcination, roasting and smelting – reduction using carbon and other reducing agents – electrolytic reduction – hydrometallurgy – Ellingham diagram. Refining of metals – electrolytic refining – oxidative refining – zone refining – Van Ankel method.

Extractive metallurgy of Li, Ni, Ti and U – Ferrous metallurgy – manufacture of steel by open hearth process – Alloys – composition and uses of German silver, Brass, Broze, Gunmetal, Alnico.

Unit-IV Chemistry in Non- aqueous solvents:

Classification of solvents, properties, levelling effect, type reactions in solvents, chemistry of liquid ammonia, liquid dinitrogen tetraoxide and anhydrous sulphuric acid with respect to properties, solubilities and reactions.

Unit-V Organometallic compounds

Definition – classification based on the nature of metal-carbon bond. Metal carbonyls – 18 electron rule – Mononuclear and polynuclera carbonyls (give examples of Fe, Co, Ni) – Bonding in metal carbonyls – Preparation of carbonyls of Fe and Ni.

Ferrocene – Preparation, properties and structure – Bonding in ferrocene (only qualitative treatment).

Applications of Organometallic compounds – Ziegler-Natta catalyst, Wilkinson catalyst

SPPC-202: Laboratory Experiments

1. To prepare methyl salicylate from salicylic acid.
2. To prepare picric acid from phenol.
3. Separation and analysis of two component systems and preparation of their derivatives
4. Separation and analysis of two component systems and preparation of their derivatives
5. Separation and analysis of two component systems and preparation of their derivatives
6. Separation and analysis of two component systems and preparation of their derivatives

Course Learning Outcomes (CLOs) :

After completing the course the student has gained a significant knowledge on
CLO-1: Formal group theory, including representations, and familiar with its applications to molecular symmetry.
CLO-2: Bonding in transition compounds by MOT.
CLO-3: Difference between crystalline and amorphous solids, recognize symmetry elements of molecules and simple crystal structures.
CLO-4: Properties and extraction of alkali metals and alkaline earth metals
CLO-5: Carbon allotropes, halogens, Nobel gases synthesis, properties, uses, structure & bonding

Text books :

1. F.A. Cotton , Chemical application and group Theory, Wiley, 3rd edition, ISBN: 978-0-471-51094-9
2. 2. F.A. Cotton, G. Wilkinson, C.A. Murillo, M.Bochmann, Advanced Inorganic Chemistry, Wiley, 6th Edn. (2003), ISBN: 978-0-471-19957-1
3. H. Jaffe' and M. Orchin , Symmetry in Chemistry, Dover Publication. Inc, 1st Edition, ISBN-13 : 978-0486421810

Reference books :

4. P.K. Bhattacharya, Group theory and its chemical application, Himalaya Publishing House, 2nd edn. (1989), ISBN-13 : 978-8184884760
5. Shriver and Atkins, Inorganic Chemistry, Oxford, 4th edn. (2003), ISBN 978–1–42–921820–7

Online links for study & reference materials :

1. https://onlinecourses.nptel.ac.in/noc21_cy16
2. https://www.academia.edu/35126326/Inorganic_Chemistry_Atkins_Shriver_PDF
3. https://chem.libretexts.org/Courses/University_of_California_Davis/UCD_Chem_110B%3A_Physical_Chemistry_II
4. http://xrayweb.chem.ou.edu/notes/symmetry.html
5. https://chem.libretexts.org https://www.britannica.com/science/alkaline-earth-metal

Course Code : STPC-203 **Course Name: ORGANIC CHEMISTRY-II**

Course Credit Hour : 4hr **Total Contact Hour : 60hr**

Course Objective :

- After completion of the course, the learner shall be able to understand Structure and aromaticity, Electrophilic substitution reactions, molecular-rearrangements and heterocyclic chemical reactions with mechanisms.

Course Description :

- This course summary shall indicate the specific key topics of the aromaticity, electrophilic substitution reactions, heterocyclic compounds, basicity, preparations and reactions with mechanisms, molecular-rearrangements and Occurrence and physiological importance natural carbohydrates, pigments, alkaloids.

Course Contents : L-4 T-0 P-2

Unit-I Reactions of benzene & phenol: Structure and aromaticity; Electrophilic substitution reactions: halogenation, nitration, sulphonation, Friedel-Crafts alkylation and acylation. Phenols: Acidity, electrophilic substitution reactions (halogenation, nitration and sulphonation); mechanism of Reimer-Tieman reaction, Kolbe reaction.

Unit-II Heterocyclic Chemistry:

Five membered heterocycles – Furan, Pyrrole and Thiophene, Condensed five membered heterocycles – Benzofuran, Indole and Benzothiophene, Pyridine,

Quinoline and Isoquinoline, Rings with more than one heteroatom 1, 2 –Azoles and 1, 3-Azoles, Purines and Pyrimidines.

Unit-III Natural products:

Carbohydrates: Introduction to naturally occurring sugars: Deoxysugars, aminosugars, branched sugars. Structure elucidation of lactose, D-glucosamine and mesoinositol. Structure and applications of inositol, starch, cellulose, chitin and heparin. **Natural pigments:** General structural features, occurrence, biological importance and applications of carotenoids, anthocyanins, quinones, flavones, pterins and porphyrins (chlorophyll). **Alkaloids:** Occurrence and physiological importance of morphine, coniine and papaverine. Structure elucidation of papaverine.

Unit-IV Rearrangements: Reactive intermediate, Carbocations, carbanions,carbenes, nitrenes Beckmann, Hofmann, Curtius, Schmidt, Wolf, Lossen, Baeyer – Villiger, Sommelet, Favorskii, Pinacole – Pinacolone, Benzil – Benzillic acid, Claisen and Cope Rearrangements, Fries Migration.

Unit V: Addition to Carbon – Hetero Multiple bonds, Addition of Grignard Reagent, Organo Zinc, Organo Copper, and Organo lithium reagents to Carbonyl and unsaturated Carbonyl compounds.

SPPC-203- Laboratory Experiments

1. To estimate the amount of Nickel present in the whole of given solution.
2. To estimate the amount of copper present in the whole of given solution.
3. Qualitative analysis of inorganic mixture
4. Qualitative analysis of inorganic mixture
5. Qualitative analysis of inorganic mixture
6. Qualitative analysis of inorganic mixture

Course Learning Outcomes (CLOs) :

CLO-1 : To learn the aromaticity, electrophilic substitution reactions. Phenols-acidity comparison, electrophilic substitution reactions and mechanism with examples.

CLO-2 : To learn the heterocyclic compounds, comparison of basicity, preparations and reactions with mechanisms

CLO-3 : To learn the various molecular-rearrangements mechanism with examples.

CLO-4 : To learn the occurrence and isolation techniques, physiological importance natural carbohydrates, pigments, alkaloids.

Text books :

1. Morrison, R. N.; Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. Finar, I. L. Organic Chemistry (Volume 1 & 2), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
3. Kapoor, K.L. (2014), A Textbook of Physical Chemistry,Vol 2, 6th Edition, McGraw Hill Education.
4. Bahl, A; Bahl, B. S. (2012), Advanced Organic Chemistry, S. Chand.

Reference books :

5. F. A. Carey, Organic Chemistry, Seventh Edition, Tata McGraw Hill (2008).
6. J. Clayden, N. Greeves, S. Warren, Organic Chemistry, 2nd Ed., (2012), Oxford Universitiy Press.
7. F. A. Carey, R. J. Sundberg, Advanced Organic Chemistry, Part A: Structure and mechanism, Kluwer Academic Publisher, (2000).
8. Wiley-Interscience, 5th edition, 2001, ISBN 0-471-58589-0
9. Wiley-Interscience, 6th edition, 2007, ISBN 978-0-471-72091-1

Online links for study & reference materials :

1. http://www.freebookcentre.net/Chemistry/Organic-Chemistry-Books.html
2. https://chem.ucr.edu/curricular-materials/textbook
3. https://www2.chemistry.msu.edu/faculty/reusch/VirtTxtJml/intro1.htm
4.https://chemistry.com.pk/free-download-chemistry-books/
5. https://bookboon.com › chemistry-ebooks
6.**https://bookauthority.org/books/best-industrial-chemistry-books**

Course Code :STPC-204 Course Name: APPLIED NANOMATERIALS
Course Credit Hour : 4hr Total Contact Hour : 60hr

Course Objective :

- A graduate level introductory course to "nanotechnology". The course will cover several key aspects of applied nanomaterials, namely their synthesis, characterization, processing, and applications. Knowledge on an advanced level on the connections between structure and properties of solids, including theory and methods that can be applied in the development of new materials with particular desired properties within this field can be gained.

Course Description :

- To understand the basic concepts, fundamental principles, and the scientific theories related to various scientific phenomena and their relevancies in the day-to-day life. To learn how interdisciplinary approach helps in providing better solutions and new ideas for the sustainable developments. To develop newer materials and composites and to study their applications.

Course Contents : L-4 T-0 P-2

Unit 1. Introduction to nanotechnology and nanomaterials
Historical development, Definition. Overview of Nanostructures and Nanomaterials: classification (materials, functional materials)

Unit 2. **Synthesis**

Selection of support metals. Preparative methods: Chemical methods (sol-gel, thermal, microwave, co-precipitation, impregnation method.

Unit 3. **Characterization**
Principle, instrumentation, and applications of X-ray diffraction, Electron microscopies SEM, TEM, EDX, Scanning Probe Microscopy (SPM).
Trends and highlights in instruments and metrology

Unit 4. **Processing**

Top-down approaches, bottom-up approaches, details of porous materials and industrial applications.

5. **Applications**
Nanotechnology for sustainability (water, energy, etc), Reinforcement in Ceramics, Drug delivery, Giant magnetoresistance, etc. Nanomedicine, Environmental, health, and safety issues

SPPC-204- Laboratory Experiments

1. Synthesis of Ni-loaded Al2O3 supported porous material.
2. Synthesis of Bi-Metallic Nano-Particals by wet chemical method.
3. Synthesis of Potassium-Nitrite loaded Zr-Supported porous material by Co-Precipitation method.
4. Synthesis of Cu-loaded, Alumina supported porous material by Thermal Method.
5. Synthesis of K-loaded, Lanthnium nitrate supported peroskite oxide material by sol-gel method.
6. Synthesis of Fe-Cr loaded Zeolite by weight – impregnation method.

Course Learning Outcomes (CLOs) :

CLO-1: To understand and apply basic concepts of nanotechnology and nanoscience. Introduction to different classes of nanomaterials, including both inorganic and organic constituents; synthesis of nanomaterials , including chemical and physical vapor transport, solution chemistry, and nanofabrication methods; characterization of nanomaterials, including x-ray techniques, scanning probe.

CLO-2: To understand the different synthesis techniques used for the synthesis of nanomaterials.

CLO-3: To study the different nano-materials along with their characterization.

CLO-4: To understand the different synthesis techniques used for the synthesis of nanomaterials. To gain the understanding of approaches to the development of chemical and biological sensors based on plasmonic, spintronics, nano porosity and issues related to their translation from the research laboratory to the clinic and to point-of-care applications

CLO-5: To gain understanding of futuristic concepts like nanorobots, nanorockets, and fantastic voyage-like submarines. These objectives are packaged with discussion sessions designed to enforce out-of-the-box thinking skills, teaming work, and communications.

Textbooks:

1. "Nanomaterials, Nanotechnologies and Design: An Introduction for Engineers and Architects" by Daniel L. Schodek, Paulo Ferreira, Michael F. Ashby (Butterworth-Heinemann)
2. "Nanostructures and Nanomaterials: Synthesis, Properties, and Applications" (2^{nd} Edition) (World Scientific Series in Nanoscience and Nanotechnology) by Guozhong Cao and Ying Wang (Imperial College Press)

Reference books :

1. NANO: The Essentials: Understanding Nanoscience and Nanotechnology Paperback – by T. Pradeep (2017)
2. Introduction to Graphene-Based Nanomaterials: From Electronic Structure to Quantum Transport Luis E. F. Foa Torres, Stephan Roche, Jean-Christophe Charlier. Cambridge.
3. Nanoparticles – Nanocomposites, Nanomaterials: An Introduction for Beginners 1st Edition by Dieter Vollath, paperback

Online links for study & reference materials :

1. https://iopscience.iop.org › book › chapter

2.https://www.academia.edu/33515592/Synthesis_Structural_Optical_and_Dielectric_Properties_of_Cadmium_Sulfide_Nanoparticles_as_Photocathode_for_a_Solar_Cell

3. https://www.sciencedirect.com/science/article/pii/B9780081005576000031
4. https://www.news-medical.net/life-sciences/Characterization-of-Nanoparticles.aspx
5.https://pdfs.semanticscholar.org/5bb8/e4ab9300292793522911117e15943349e56c.pdf
6. https://www.azonano.com/article.aspx?ArticleID=1710
7.https://www.ttu.ee/public/m/Mehaanikateaduskond/Instituudid/Materjalitehnika_instituut/MTX9100/Lecture11_Synthesis.pdf
8. https://www.understandingnano.com/nanotech-applications.html
9. https://www.longdom.org/open-access/applications-of-nanotechnology-2155-983X-1000131.pdf
10. https://www.nano.gov/you/nanotechnology-benefits

SEMESTER – III

Course Code : STPC-301 Course Name: PHYSICAL CHEMISTRY-III
Course Credit Hour : 4hr Total Contact Hour : 60hr

Course Objective :

- To gain general idea about the gases and liquid states, collision theory, chemical equilibrium, electrochemistry and surface chemistry. To identify methods and instruments that can be used to study physical chemistry. Evaluate data generated by experimental methods for chemical characterization.

Course Description :

- To apply gas laws in various real life situations. To explain the behavior of real and ideal gas. To differentiate between gaseous state and vapour. To explain the kinetic theory of gases. To explain the properties of liquids. To describe condition required for liquefaction of gases. To understand chemical equilibrium, electrochemistry and surface chemistry phenomenon.

Course Contents : L-4 T-0 P-2

Unit-I Gaseous and liquid states: Absolute scale of temperature, ideal gas equation; Deviation from ideality, van der Waals equation; Kinetic theory of gases, average,

root mean square and most probable velocities and their relation with temperature; Law of partial pressures; Vapour pressure; Diffusion of gases.

Unit-II Kinetic theory of gases: Postulates of kinetic theory of gases, P-V-T relations for an ideal gas, non-ideal behavior of gases, equation of state, van der Waal's equation, relations of vanderWaal's constants with virial coefficients and Boyle temperature.

Molecular statistics, distribution of molecular states, deviations of Boltzmann law for molecular distribution, translational partition function, Maxwell-Boltzmann law for distribution of molecular velocities, physical significance of the distribution law, deviation of expressions for average, root mean square and most probable velocities, experimental verification of the distribution law. Molecular collision in gases, mean free path, collision diameter and collision number in a gas and in a mixture of gases, kinetic theory of viscosity and diffusion.

Unit-III Chemical equilibrium: Law of mass action; Equilibrium constant, Le Chatelier's principle (effect of concentration, temperature and pressure); Significance of ΔG and ΔG° in chemical equilibrium; Solubility product, common ion effect, pH and buffer solutions; Acids and bases (Bronsted and Lewis concepts); Hydrolysis of salts.

Unit-IV Electrochemistry: Electrochemical cells and cell reactions; Standard electrode potentials; Nernst equation and its relation to ΔG; Electrochemical series, emf of galvanic cells; Faraday's laws of electrolysis; Electrolytic conductance, specific, equivalent and molar conductivity, Kohlrausch's law; Concentration cells.

Unit-V: Surface chemistry: Elementary concepts of adsorption (excluding adsorption isotherms); Colloids: types, methods of preparation and general properties; Elementary ideas of emulsions, surfactants and micelles (only definitions and examples)

SPPC-301- Lab Experiments:

1. To prepare acetyl salicylic acid (aspirin) from methyl salicylate
2. To prepare benzanilide from benzoquinone
3. To prepare Meta nitro benzoic acid from methyl benzoate
4. To prepare p-Iodobenzoic acid from p-Toluidine
5. To prepare benzilic acid from benzoin.
6. To prepare β-napthol from naphthalene.

Course Learning Outcomes (CLOs) :

CLO-1: To understand the different gas laws, the kinetic theory of gases, deviations from ideal behaviour.

CLO-2: To understand the corrections made in vanderwaals equations and to learn the terminologies used such as molecular collision in gases, mean free path, collision diameter and collision number in a gas and in a mixture of gases, kinetic theory of viscosity and diffusion.

CLO-3: To study chemical equilibrium and spontaneity of reactions by using thermodynamic principles. To understand the concept of acids and bases (Bronsted and Lewis concepts) and hydrolysis of salts.

CLO-4: Students can learn depth concepts about electrochemistry. To understand the faraday's laws of electrolysis; electrolytic conductance, specific, equivalent and molar conductivity, kohlrausch's law and concentration cells. To understand cell constant and use of it to obtain specific and equivalent conductance.

CLO-5: To understand various types of colloids and its applications. To gain understanding of elementary concepts of adsorption, emulsions, surfactants and micelles.

Text books :

1. Physical Chemistry – G.M. Barrow, Tata Mc – Graw Hill – 1988
2. Quantum Chemistry - I. Levine, Fifth edition, Prentice Hall- 1999
3. Essentials of Physical chemistry - Bahl and Tuli, S. Chand- 2012

Reference books :

1. Atkins P.W., Paula, J. De, Physical Chemistry, W.H. Freeman, 2012 ELBS fourth edition.
2. Physical Chemistry – R.A. Alberty, R.I. Bilby, Johy Wiley – 1995
3. McQuarrie, D. A., Statistical Mechanics, Viva Books Pvt. Ltd.: New Delhi, 2013.

Online links for study & reference materials :

1. https://courses.lumenlearning.com/introchem/chapter/kinetic-molecular-theory-and-gas-laws/
2. http://www.chem.hope.edu/~polik/Chem3451997/gasviscosity/GasViscosity.html
3. https://chem.libretexts.org/Textbook_Maps/Physical_and_Theoretical_Chemistry_Textbook_Maps/Supplemental_Modules_(Physical_and_Theoretical_Chemistry)/Equilibria/Le_Chatelier's_Principle

4. https://www.nature.com/subjects/surface-chemistry

Course Code : STPC-302 Course Name: Synthetic Organic Chemistry
Course Credit Hour : 4hr Total Contact Hour : 60hr

Course Objective :

- To provide extensive knowledge about molecular organometallic chemistry. To know the most important classes of ligands found in organometallic compounds. To provide broad knowledge of nomenclature, coordination modes, geometries, and fundamental reaction types. To get knowledge of the chemical bonds and the theories that explain the electronic properties within organometallic compounds. To know how to establish the relationship between the structures, chemical bonds in organometallic chemistry to determine and elucidate mechanisms in catalysis

Course Description :

- Transition metals are becoming more and more important in modern organic synthesis. This is particularly true for organic transformations which are impossible or difficult to achieve by classic organic chemistry. The important role of organometallic complexes within catalysis will be discussed. The transition metal complexes bonds, structures and reactions will also be discussed. Special emphasis will be put on the application of organometallic complexes in organic synthesis. Basic knowledge is provided with regards to polymer and polymerization.

Course Contents : L-4 T-0 P-2

Unit-I Transitional metals complexes in organic synthesis
Transition metal complexes in organic synthesis-Introduction-oxidation states of transition metals, 16-18 rule, dissociation, association, insertion, oxidative addition, reductive elimination of transition metal

Unit-II Organo nickels- coupling carboxylation, amination, carbonylation

Unit-III Chromium carbonyls regioselective alkylation and acylation of aromatics, nucleophilc substitution, lithiation reaction, Reactions Iron carbonyls, ferrocenes, Fe-cyclopentadiene complex, protection of dienes, isomerization.

Unit-IV Wilkinson, Noyori, Knowls catalyst of Ruthenium and Rhodium – synthesis and uses its use in hydrogenation reactions-dealkylation, C-C, C-O, C-N bond cleavages

Unit-V Polymers

Polymers, monomers, Molecular weight and molar mass, End groups, Degree of polymerization, Nomenclature Classification of polymer-thermoplastic, thermosetting Copolymers- random, alternate, block and graft copolymers, Molecular architecture Polymerization and functionality Polymerization processes- Addition and step polymerization, Mechanism of polymerization – free radical and ionic.

Molecular Weight of polymers – Arithmetic, weight average and number average molecular weights of polymers Determination of molecular weight of polymers End-Group Analysis Cryoscopy, Light scattering, Viscosity, and gel permeation chromatographic methods. Thermal Transition in Polymers, DSC, TGA Spectral methods of Analysis

SPPC-302: Lab Experiments:

1. To determine the cell constant and equivalent conductance of a strong electrolyte at infinite dilution. (verification of Debye- Huckel Onsagar equation)
2. To verify the Ostwald's dilution law and to determine the dissociation constant of the weak electrolyte.
3. Determination of relative strengths of the given 2 acids catalysed by methyl acetate
4. To estimate the amount of iron present in the whole of given solution.
5. To determine the amount of manganese in the given solution by colorimetric method
6. To determine the Specific Gravity of soil a particle passing through 4.75 mm IS sieve using Density bottle.

Course Learning Outcomes (CLOs) :

After completing the course, the candidate will have the following knowledge and able to

CLO-1: To solve problem formulations and methodologies for use of organometallic compounds in organic synthesis.

CLO-2: To evaluate when it is appropriate to use organometallic compounds in organic synthesis..

CLO-3 : To explain bonding in metal complexes and the magnetic behaviour of complexes and its application

CLO-4 : To define the nomenclature, electronic structure, properties of transition-metal compounds.

CLO-5: Is able to identify the basic fundamental reactions in organometallic chemistry.

CLO-6: Is able to describe the bond-to-metal complexes, establish the structure-reactivity/activity relationship and the operating mechanisms in the catalytic processes.

Text books :

1. Modern synthetic reactions – H. O. House (Benjamin)
2. Some modern methods of organic synthesis – W. Carruthers (Cambridge)
3. [illegible]
4. Comprehensive organometallic chemistry-Vol. Chiron approach in organic synthesis – S. Hanessian (Relavent chapters For Chirons)
5. Carbocyclic non-benzenoid aromatic compounds, D. Lloyd Text Book of Polymer Science by F. W. Bilmayer
6. Polymer Science by Gowarikar
7. Introduction to polymer science and chemistry by ManasChanda, Taylor and Francis Pub.

Reference books :

1. J.D.Lee, Concise Inorganic chemistry, ELBS (1986) , 5th Edition, ISBN-10: 0632052937
2. A.G.Sharpe, Inorganic Chemistry, ELBS, 4th Edition (1984). I*SBN* 978-0-273-74276-0
3. Inorganic Chemistry: D.F.Shriver, P.W.Atkins, 3rd Edition, Oxford University press (1999), 9780199236176 0199236178 9781429218207 1429218207
4. P. Powell, Principles of Organometallic Chemistry, 2ed, ELBS, 1991. ISBN 13:978-94-010-9681-2
5. J. E. Huheey, Inorganic Chemistry, 4ed, Harper International, 2002
6. A.F. Wells , Structural Inorganic Chemistry, 5th Edition (1984), *ISBN*-10 : 0198553706; *ISBN*-13 : 978-0198553700
7. F. N. Billmeyer, Textbook of Polymer Science, Wiley Interscience, 1971, 2nd edition, ***ISBN***-10 : 0471072990; ***ISBN***-13 : 978-0471072997
8. Robert H. Crabtree, The Organometallic Chemistry of the Transition Metals, wiley, 6th Edition,ISBN 13:9781118138076
9. B D Gupta, A J Elias, Basic Organometallic Chemistry: Concepts, Syntheses and Applications, Universities Press, 1st edition,ISBN-13 : 978-8173717093

Online links for study & reference materials :

1. https://onlinecourses.nptel.ac.in/noc21_cy12
2. https://www.youtube.com/watch?v=3FRV31YYtL8

3. https://www.youtube.com/watch?v=8pqCeN7GoMc
4. https://chem.libretexts.org
5. https://pubs.rsc.org/en/content/articlelanding/2009/gc/b915563p

Course Code : STPC-303 Course Name: DRUG SYNTHESIS
Course Credit Hour : 4hr Total Contact Hour : 60hr

Course Objective :

- General structural features of agents belonging to the therapeutic class. Relevant physicochemical properties. Relevant chemical reactions/synthetic pathways for selected drugs. Structural influences on mechanism of pharmacologic action (structure-activity relationship). Structural influences on pharmacologic/toxicological/therapeutic profiles.

Course Description :

- The course gives an introduction to the most common synthetic methods that are applied in industrial and laboratory drug synthesis. The course deals with Structure, stereochemistry, Mode of action, Structure activity relationships, synthesis of drugs and with the molecular mechanism of drug action.

Course Contents : L-4 T-0 P-2

Structure, stereochemistry, Mode of action, Structure activity relationships, specific clinical applications of following classes of pharmaceuticals with synthetic/commercial route to the indicated examples.

1. Antibacterials: Penicillines, Cephalosporins, Tetracyclines, Aminoglycosides, Chloramphenicol, Macrolides, Lincomycins, Polypeptides antibiotics, Polyene antibiotics. Sulfonamides and Sulfones fluoroquinolines, Trimethoprim and other unclassified antibiotics. Antimycobacterials: Sulfanilamides, p-Aminosalicyclic acid derivatives, Thioamides, Thiourea, derivatives, Thiosemicarbonazones, Isoniazid, Kanamycin sulfate, Capreomycin, Rifaampin, Pyrazinamide, Anthionamide, Clofazimine, Cyclosporin, Dapsone, Sulfazem. Commercial synthetic/semi-synthetic routes to : 6-amino penicillanic acid, ampicillin, amoxycillin, production of penicillin, 7- amino cephalsporanic acid, cephalexin, ceftizoxime, cefaclor, cephslothin, Tetracyclins: doxycycline, nalidixic acid, sulfadiazine, Norflaxacin, Ciproflexacin, O-flaxacin, Amiflaxacin, Difloxacin, Chloramphenicol, Nitroflurantion, Sulfamethyoxazole, Acetysulfoxiazole, Trimethoprim.

2. Antimalarials: Cinchona alkaloids, 4-Aminoquinolines, 8-Aminoquinolines, 9-Aminoacridines, Biguanides, Pyramidines and Sulfones, Mefloquine, Sulfonamides. Commercial synthetic routes to: Chloroquine, pamaquine, primaquine, proguanil, Amodiaquine, Mefloquine, Pyremethamine, Sontoquine.

3. Antiamoebic and antiprotozoal drugs: Emetine hydrochloride, 8-Hydroxyquinoline, Iodochlorohydroxyquinol, Metronidazole, Diloxanide furoate, Bilamical hydrochloride, Hydroxystilbamidine isothinate, Pentamidine isothionate, Nifurtimox, Suramin sodium, Carbarsone, Glycobiarsol, Melarsoprol, Sodium stibogluconate, Dimercaprool, Diethylcabamazine citrate, Centarsone, Acetarsone, Antimony potassium tartarate, Bismuth sodium thioglycollate, Sulphonamide, Stibiophen. Bismuth sodium thioglycollamate, Furazolidone.

4. Anthelmintics: Introduction, Tetrachloroethylene, Piperazines, Gentian violet, Pyrvinium pamoate, Thiabendazole, Mabendazole, baphenium hydroxynaphthoate, Dichlophene, Niclosamide, Levamisole hydrochloride, Tetramisole, Niridazole, Biothional, Antimonypotassium tartarate, Stibiophen, Sodium Stibiocaptate.

5. Antifungal drugs: Fatty acids and their derivatives (Propionic acid, zinc propionate, sodium caprylate, zinc caprylate, undecylenic acid, Zinc undecylenate, Triacetin), Salicylanilids, Salicyclic acid, Tolnaftate, pchloromethoxylenol, Acrisocrin, Fluconazole, Itraconazole, Haloprogin, Clotrimazole, Econazole, Miconazole, Ketoconazole, Flucytosine, Griseofulvin, Polyene antibiotics (Nystatin, Amphoetericin-B), Chlorophenesin, Dithranol. Commercial synthetic routes to: Miconazole, Clotrimazole, Econoazole, Fluconazole, Griseofulvin, Ketoconazole, Nafttidine, Tolnaftate, Flucytosin.

Course Learning Outcomes(CLOs) :

After completion of the course student will be able to understand/explain

CLO-1 : Recognize the drug structure and predict its pharmacologic action.

CLO-2 : Relevant chemical reactions/synthetic pathways for selected drugs

CLO-3 : Knowledge of the connection between the structural features of the drugs and their physico-chemical characteristics, mechanism of action and use.

CLO-4: Application the gained knowledge about the drugs. Counseling and giving information to patients about the drug action.

SPPC-303: Lab Experiments:

1. Synthesis of Paracetamol
2. Synthesis of NO-SPA (drotaverine hydrochloride)
3. Synthesis of Pyralginum, Analgin (metamizole sodium)
4. Synthesis of Ascodan (acetylsalicylic acid + codeine phosphate)
5. Synthesis of Etopiryna (acetylsalicylic acid + ethenzamide + caffeine)
6. Synthesis of Cardiamidum (cardiamide, nikethamide, drug in drops)

7. Synthesis of Unguentum undecylenicum (undecylenic acid and its zinc salt, drug in ointment form)
8. Synthesis of Ibuprofen (drug in suspension form)
9. Synthesis of Guaiafenezin (Williamson ether synthesis and isolation from tablets)

Books Recommended:

1. 1. Thomas L. Lemke, David A. Williams, Victoria F. Roche, S. William Zito, Foye's Principles of Medicinal Chemistry, 7th Ed.,Lippincott Williams & Wilkins, 2012,ISBN 13: 9780781768795
2. Graham L. Patrick, "An Introduction to Medicinal Chemistry", 5th Ed. Oxford University Press 2013, ASIN : 0199697396
3. Wilson and Gisvolds Textbook of Organic Medicinal and Pharmaceuticals Chemistry, 8th edition, edited by R.F. Deorge, J.B. Lippincott Company, Philadelphia, 1982, ISBN 978-0-7817-7929-6
4. Jie Jack Li, Douglas S. Johnson, Modern Drug Synthesis, Wiley, 1st Edition, **ISBN:** 9780470768594
5. Pharmaceutical Chemicals in Perspective. B.G. Reuben and H.A. Wittcoff, John Wiley & Sons, New York, 1989., 1st Edition, ISBN 13: 9780471540366
6. Rama Rao nadendla, Principles of Medicinal Chemistry, New Ace publisher, 1st Edition, ISBN (13) : 978-81-224-2485-0

References Books:

1. Strategies of Organic Drug Synthesis and Design, D. Lendnicer, John Wiley and Sons, New York, 1998.
2. Pharmaceutical Chemicals in Perspective. B.G. Reuben and H.A. Wittcoff, John Wiley & Sons, New York, 1989.
3. W.C. Foye, Principles of Medicinal Chemistry, Lea & Febiger, Philadelphia, U.S.A. Suggested Readings 1. Strategies of Organic Drug Synthesis and Design, D. Lendnicer, John Wiley and Sons, New York, 1998.

Online links for study & reference materials :

1. https://pubs.acs.org/doi/abs/10.1021/jm00388a027
2. https://www.sciencedirect.com/book/9780444521668/synthesis-of-essential-drugs
3. https://cmr.asm.org/content/12/4/501
4. https://www.sciencedirect.com/book/9780444521668/synthesis-of-essential-drugs, An introduction to medicinal chemistry, Graham L. Patrick

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Course Code : STPC-304 Course Name: INDUSTRIAL CHEMISTRY
Course Credit Hour : 4hr Total Contact Hour : 60hr

Course Objective :

- After completion of the course, the learner shall be able to understand about the industrial processes of various types of the chemical and derivatives preparation in industrial scale and challenges. Have sound knowledge of pharmaceuticals, cosmetics, perfumes and pesticides. Become well equipped to design, carry out, record and analyze the industrial preparations. Understand the ethical, historic, philosophical, and environmental dimensions of problems and issues facing industrial chemists. Become skilled in problem solving, critical thinking and analytical reasoning. Identify and solve chemical problems and explore new innovative areas of research. Know the proper procedures and regulations for safe handling and use of chemicals and can follow the proper procedures.

Course Description :

- This course summary shall indicate the specific key topics of the Food-flavours, colours, preservatives, Production, and purification of ethyl alcohol, citric acid, lactic acid, Vitamin B12, Penicillin, fertilizers-classification, types, industrial preparation process, types and industrial process of glass and ceramics, Paints-classification, constituents, binders, solvents, Fats and oils.

Course Contents : L-4 T-0 P-2

Unit-I:
Food Additives: Food flavour, food colour, food preservatives, artificial sweeteners, acidulants, alkalies, edible emulsifiers and edible foaming agents, sequesterants – uses and abuses of these substances in food beverages.
Fermentation Chemicals: Production, and purification of ethyl alcohol, citric acid, lactic acid, Vitamin B12, Penicillin.

Unit-2:
Fertilizers: Manufacture of ammonia and ammonium salts, urea, Superphosphate, biofertilizers.

Unit-3:
Glass and Ceramics: Definition and manufacture of glasses, optical glass and coloured glass. Clay and feldspar, glazing and vitrification, glazed porcelein, enamel. Portland cement: composition and setting of cement, white cement.

Unit-4:
Paints, Varnishes and Synthetic Dyes: Primary constituents of a paint, binders and solvents for paints. Oil based paints, latex paints, baked-on paints (alkyd resins). Constituents of varnishes. Formulation of paints and varnishes. Synthesis of Methylorange, Congo red, Malachite green, Crystal violet.

Unit-5:

Fats-Oils-Detergents: Fats and oils, natural fat, edible and inedible oil of vegetable origin. Common fatty acids, glycerides. Hydrogenation of unsaturated oil, Production of toilet and washing soaps, detergent powder, liquid soaps.

SPPC-304-List of Laboratory Experiments

1. Preparation and Properties of a Soap
2. The Preparation and Verification of Malachite
3. Sulphur trioxide - the sulphuric acid contact process
4. Preparation of iron from oxidic ores (blast furnace process)
5. Evaluation of Detergents and Cleaning Aids
6. Checking the purity of Toothpaste
7. Preparation of a skin cream
8. Titration: Standardization of a base and analysis of stomach antacid tablets.

Course Learning Outcomes (CLOs) :

CLO-1 : To learn about various types of Food-flavours, colours, preservatives, Production, and purification of ethyl alcohol, citric acid, lactic acid, Vitamin B12, Penicillin.

CLO-2 : To learn about various types of fertilizers-classification, types, industrial preparation process.

CLO-3 : To learn about various types of industrial process of glass and ceramics,
CLO-4 : To learn about various types of Paints-classification, constituents, binders, solvents with case studies.

CLO-5 : To learn about various types of Fats and oils-classification, preparation, constitutes with case studies.

Text books :

1. R.M. Felder, R.W. Rousseau: Elementary Principles of Chemical Processes, John Wiley & Sons, Inc. Publishers, New Delhi.(2005 edition).
2. J. A. Kent: Riegel's Handbook of Industrial Chemistry, CBS Publishers, New Delhi.
3. Richard Turton, Wallace B Whiting, Richard C Bailie Analysis, Synthesis and Design of Chemical Processes, 2020, Addison Wesley, ISBN-13: 9780134177403

Reference books :

1. George T. A. (1977). Shreve's Chemical Process Industries. 5th edn. McGraw-Hill International Edition. Chemical Engineering Series. Singapore.
2. Chang R. and Tikkanen W. (1988). The Top Fifty Industrial Chemicals. Random House, New York.
3. Price R.F. and Regester M.M. (2000), WEFA Industrial Monitor, 2000-2001, John Wiley & Sons Inc., New York. Chang R. (1991). Chemistry, 4th Edition, McGraw-Hill Inc. New York.
4. Shukla S. D and Pandey G. N, (1978). A Textbook of Chemical Technology. Vol.1 (Inorganic/Organic). Vikas publishing House PVT Ltd. New Delhi.
5. Stephenson R.M. (1966). Introduction to the Chemical Process Industries, Reinhold Publishing Corporation, New York.
6. Groggins P.H. (1958). Unit Processes in Organic Synthesis, 5th Edition, McGraw-Hill Book Company, New Delhi.
7. Das R.K. (1988) Industrial Chemistry: Metallurgy, Kalyani Publishers, New Delhi. Gerhartz, W. (Editor), (1987). Ullmann's Encyclopaedia of Industrial Chemistry Vol A8, 5th Edition, VCH Verlagsgesellschaft mbH, Weinheim.

Online links for study & reference materials

1. https://bookboon.com › chemistry-ebooks
2. https://www.researchgate.net/publication/257417805_Industrial_Chemistry
3. https://chemistry.com.pk/free-download-chemistry-books/
4. https://www.kopykitab.com/Industrial-Chemistry-1-by-Dr-G-S-Gugale-Dr-A-V-Nagawade-Dr-R-A-Pawar-Dr-K-M-Gadave
5. https://www.internetchemistry.com/chemistry/industrial-chemistry.php
6. **https://bookauthority.org/books/best-industrial-chemistry-books**

SEMESTER – IV

Course Code : STPC-401 Course Name: POLYMERS AND PLASTICS
Course Credit Hour : 4hr Total Contact Hour : 60hr

Course Objective :

- The aim of the course is to familiarize students with electrochemical processes occurring in the solid state. Quantitative determination of degree of polymerization and molecular weight distribution.

Course Description

- Polymer Chemistry is a course that introduces students to Polymer science, engineering and technology, types of polymer, reactions to form polymer, polymerization mechanisms, structures, properties and applications.

Course Contents : L-4 T-0 P-2

Unit-I

Basic concepts. Nomenclature- Degree of polymerization – polymerization process – Classification of polymerization reactions – Difference between thermoplastics and thermosets. Types of polymerization – Addition and step growth.

Unit II

Copolymerization- Block copolymerization – Graft copolymerisation. Stereo isomers – isotactic, atactic and syndyotactic polymers. Mechanism of polymerization – free radical and ionic. Heterogeneous polymerization – Zeigler-Natta catalysis. Compounding of plastics – Fabrication techniques of plastic.

Unit III

Polymer degradation – Types of degradation – thermal, mechanical, ultrasonic waves, photo-degradation, oxidative degradation (rubber and phenol-formaldehyde) and hydrolytic degradation.

Kinetics of polymer reaction – addition – Free-radical, cationic and Anionic polymerization. Condensation polymerization – acid catalysed condensation reactions.

Unit –IV

Analysis and testing of polymers – weight average nad number average molecular weights of polymers ratio of M_w and M_n. Determination of molecular weight of polymers by Cryoscopy – Light scattering – X-ray scattering – Viscosity – Ultra centrifuge and gel permeation chromatographic methods.

Unit –V

RUBBERS, ELASTOMERS AND ADHESIVES

Origin and chemical nature of natural rubber – D irect processing of lLatex – Compounding of rubber – Fabrication of rubber – Vulcanization of rubber. Elastomers – Manufacture, properties and uses of Butadiene, Isoprene and chloroprene. Natural and synthetic adhesives- Classification animal glue. Protein and starch adhesives – Resin adhesives. Difference between plastics, elastomers and adhesives.

Course Learning Outcomes (CLOs) :

CLO-1: The subject provides an introduction to polymer science with respect to synthesis, polymerization kinetics and network formation/gelation of macromolecules formed by step-growth and chain-growth polymerization. Polymer

structure/conformation and transitions from liquid (melt, solutions) to solid (polymer crystals and –glass) states are discussed using equilibrium thermodynamics, kinetics and free volume considerations. Polymer solubility/miscibility and phase diagrams are determined using thermodynamic parameters.

CLO-2: An overview of mechanical and rheological properties of polymers is also given. Specialized synthesis for flow assurance industry.

CLO-3: Study of kinetic polymer reactions and degradation.

CLO-4: Molecular weight determination of polymers is shown using osmotic pressure, viscometry and size exclusion chromatography (SEC).

CLO-5: To differentiate between natural and man-made polymers, plastics, elastomers and adhesives.

Text books :

1. Engineering Chemistry, Jain and Jain, Dhanpat Rai Publishing Company, 15th Edition.
2. Chemicals from petroleum, A. L. Waddns and J. Murray, ELBS Edn. 1970.
3. Chemical process Industries 5th Ed, George T. Austin, Mc Graw- Hill company Inc. 1984.
4. Textbook of polymer science, P. W. Billmeyer, John Wiley, 1962.
5. Petroleum products Hand Book, Virgil.B Guthhrie, Editor, 1st ed Mc Graw Hill book company Inc 1960.
6. Polymer science, V.R. Gowariker et al ., New Age Intl (P)Ltd, New Delhi.
7. Organic chemistry of synthetic High Polymers, Robert W. Lenz, Interscience Publishers.

Reference books :

1. Industrial chemistry by B. k Sharma, 5th Ed. 1993.
2. Introduction to Polymer Chemistry, Raymond B, Seymour.

Online links for study & reference materials:

1. https://www.accessengineeringlibrary.com/browse/polymer-science-and-technology-plastics-rubbers-blends-and-composites-third-edition
2. https://books.google.co.in/books?id=BS-hAgAAQBAJ&printsec=frontcover&source=gbs_ge_summary_r&cad=0#v=onepage&q&f=false
3. https://books.google.co.in/books?id=BS-hAgAAQBAJ&printsec=frontcover&source=gbs_ge_summary_r&cad=0#v=onepage&q&f=false

4. http://cryssmat.fq.edu.uy/ricardo/libro.pdf
5. http://courses.washington.edu/mengr553/Polymers.pdf

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6. https://www.pharosproject.net/uploads/files/sources/1828/1371736918.pdf
7. https://www.mdpi.com/2073-4360/5/1/225.

Course Code : STPC-402 Course Name: INTELLECTUAL PROPERTY RIGHTS
Course Credit Hour : 4hr Total Contact Hour : 60hr

Course Objective :

- In this era of liberalization and globalization, the perception about science and its practices have undergone dramatic change. The importance of protecting the scientific discoveries, with commercial potential or the intellectual property rights is being discussed at all levels – statutory, administrative, and judicial. With India ratifying the WTO agreement, it has become obligatory on its part to follow a minimum acceptable standard for protection and enforcement of intellectual property rights. The purpose of this course is to apprise the students about the multifaceted dimensions of this issue. To introduce fundamental aspects of Intellectual property Rights to students who are going to play a major role in development and management of innovative projects in industries. To disseminate the knowledge on patents, patent regime in India and abroad on registration aspects. To disseminate the knowledge on copyrights and its related rights. To disseminate knowledge on trademarks and registration aspects. To disseminate knowledge on Design, Geographical Indication (GI), Plant Variety and Layout Design Protection and their registration aspects. To aware about current trends in IPR and Govt. steps in fostering IPR.

Course Description :

- This course is an intensive study of the core subjects of intellectual property law: patents, copyrights, trade secrets, and trademarks. It examines the fundamental principles of these bodies of law, their underlying policies, and how the laws inter-relate. Course will provide the comprehensive knowledge to the students regarding Indian position of the Patent Law (1970), Historical development, Procedure for granting a patent, Infringement. Comprehensive knowledge to the students regarding Indian position of the Copyright Law, 1957, Historical background and Development of Copyright Law, Infringement. Comprehensive knowledge to the students regarding Indian position of the Trademark Act, 1999, Historical development of the concept of trademark and trademark law, Registration of trademark, Infringement of trademark, geographical indications and for industrial designs too.

Course Contents : L-4 T-0 P-2

Unit I: Introduction to Intellectual Property
Historical Perspective, Different Types of IP, Importance of protecting IP.

Unit II: Copyrights
Introduction, How to obtain, Differences from Patents.

Unit III: Trade Marks
Introduction, How to obtain, Different types of marks – Collective marks, certification marks, service marks, Trade names, etc. Differences from Designs.

Unit IV: Patents
Historical Perspective, Basic and associated right, WIPO, PCT system, Traditional Knowledge, Patents and Healthcare – balancing promoting innovation with public health, Software patents and their importance for India.

Unit V: Geographical Indications
Definition, rules for registration, prevention of illegal exploitation, importance to India.

Unit VI: Industrial Designs
Definition, How to obtain, features, International design registration.

Course Learning Outcomes (CLOs) :

CLO 1: The students once they complete their academic projects, shall get an adequate knowledge on patent and copyright for their innovative research works

CLO 2: During their research career, information in patent documents provide useful insight on novelty of their idea from state-of-the art search. This provides further way for developing their idea or innovations

CLO 3: Pave the way for the students to catch up Intellectual Property (IP) as a career option

a. R&D IP Counsel

b. Government Jobs – Patent Examiner

c. Private Jobs

d. Patent agent and Trademark agent

e. Entrepreneur

Text books :

1. N.S. Gopala krishnan and T.G. Agitha, (2009) Principles of Intellectual Property Eastern Book Company, Lucknow.
2. David Kitchin QC , David Llewelyn , James Mellor , Richard Meade , Thomas Moody-Stuart,and D. Keeling, Robin Jacob (2005). Kerly's Law of Trade Marks and Trade Names (14th Edition) Thomson, Sweet & Maxweel.
3. Ajit Parulekar and Sarita D' Souza, (2006) Indian Patents Law – Legal & Business Implications; Macmillan India Ltd.
4. B.L.Wadehra (2000) Law Relating to Patents, Trade Marks, Copyright, Designs &Geographical Indications; Universal law Publishing Pvt. Ltd., India.
5. P. Narayanan (2010) Law of Copyright and Industrial Designs; Eastern law House, Delhi.

Reference books :

1. N.K. Acharya: *Textbook on intellectual property rights,* Asia Law House (2001).
2. Manjula Guru & *M.B.* Rao, *Understanding Trips: Managing Knowledge in Developing Countries*, Sage Publications (2003).
3. P. Ganguli, Intellectual Property Rights: *Unleashing the Knowledge Economy,* Tata McGraw-Hill (2001).
4. Arthur Raphael Miller, Micheal H.Davis; *Intellectual Property: Patents,Trademarks and Copyright in a Nutshell,* West Group Publishers (2000).
5. Jayashree Watal, *Intellectual property rights in the WTO and developing countries,* Oxford University Press, Oxford.

Online links for study & reference materials :

http://cipam.gov.in/

(https://www.wipo.int/about-ip/en/

(http://www.ipindia.nic.in/

http://www.bdu.ac.in/cells/ipr/docs/ipr-eng-ebook.pdf