GUJARAT UNIVERSITY
MSc Inorganic Chemistry Semester III and IV
Revised Syllabus
Design and Structure of Choice Based Credit System
(Effective from June 2023)

MSc Semester III						
Course		No. of hours per week (12 h for each unit and 48 h for each paper/course)			Total credits	Marks
Paper Code	Type	Lectures	Labs	Total		
CHE (I) 501	Core Paper	4	--	4	4	100
CHE (I) 502	Core Paper	4	--	4	4	100
CHE (I) 503	Core Paper	4	--	4	4	100
CHE (EI) 504	Elective Paper	4	--	4	4	100
CHE (I) 505 PR	Lab Course 1	--	6	6	4	100
CHE (I) 506 PR	Lab Course 2	--	6	6	4	100
	Total	16	12	28	24	600
MSc Semester IV						
Course		No. of hours per week (12 h for each unit and 48 h for each paper/course)			Total credits	Marks
Paper Code	Type	Lectures/ Discussion	DISS/PW/ IT/Lab course	Total		
CHE (I) 507	Core Paper (Scientific Writing)	4	--	4	4	100
CHE (I) 508	Core Paper (Report Writing)	4	--	4	4	100
CHE (I) 509	Core paper (Industrial Training and Industrial Visit)	--	4	4	4	100
CHE (I) 510	Core Paper [Professional Chemistry Test (Last 5 Years NET questions)]	4	--	4	4	100
CHE (I) 511	Dissertation (DISS)/ Project Work (PW) OR Lab Course	--	12	12	08	200
		12	16	28	24	600

For each paper 30 % weightage is given to internal assessment and 70 % for external assessment.

SEMESTER - 3 (Inorganic Chemistry)

CHE(I) 501 Advanced Inorganic Chemistry

Objective:

To provide basic concepts, synthesis, properties and applications of Nanomaterials. The topic of Ion exchange provides the knowledge of synthesis of resins and their properties. To impart basic and advanced concepts of Supramolecular chemistry. An examination of non-covalent interactions and their impact in chemistry. Topics will include self-assembly with special emphasis on supramolecules derived from calix systems, molecular recognition, and their applications for the design and synthesis of nanostructured materials. The topic of MOFs are very new in recent era.

Unit-I	**Advances in Nanomaterials** Types of nanomaterials, e.g. nanotubes, nanorods, solid spheres, core-shell nanoparticles, Mesoporous materials; General preparative methods for various nanomaterials, Some important properties of nanomaterials: optical properties of metal and semiconductor nanoparticles, magnetic properties, Some special nanomaterials: Carbon nanotubes: Types, synthesis using various methods, growth mechanism, electronic structure; Porous silicon: Preparation and mechanism of porous silicon formation, Factors affecting porous structure, properties of porous silicon; Aerogels: Types of aerogels, Properties and applications of aerogels, Applications of nanomaterials in electronics, energy, automobiles, sports and toys, textile, cosmetics, medicine, space and defense. Environmental effects of nanotechnology	**25%**
Unit-II	**Ion Exchange** Synthesis, characterization and properties of Ion exchangers, mechanism of ion exchange: equilibria–Rate Theory, Donnan equilibria, liquid ion exchangers and chelate ion–exchange resins. Separation of metals and non-meals using ion exchangers. Inorganic ion exchangers : The clay minerals, zeolites, heteropolyacid salts, hydrous oxides and insoluble salts and their applications	**25%**
Unit-III	**Basics of Supramolecular Chemistry** Definition and development of supramolecular chemistry, Classification of supramolecular Host-Guest compounds, Receptors, coordination and lock and key analogy, Binding constants, Cooperativity and the chelate effect, Preorganisation and complementarity, Thermodynamic and kinetic selectivity and discrimination, Nature of supramolecular interactions, Solvation and hydrophobic effects, Supramolecular concepts and design	**25%**
Unit-IV	**Metal Organic Frameworks** Introduction to MOFs, Synthesis of MOFs, Post-synthetic modification of	**25%**

	MOFs, Characterization of MOFs, Characterization of MOFs, Application of MOFs as catalysts, nanoreactors, gas storage devices, etc	

Reference Books:

1. Supramolecular Chemistry by Jonathan W. Steed, Jerry L. Atwood, John Wiley & Sons, Ltd.
2. Supramolecular Chemistry: Concepts and Perspectives By Jean-Marie Lehn
3. Core Concepts in Supramolecular Chemistry and Nanochemistry By Jonathan W. Steed, David R. Turner, Karl Wallace
4. Supramolecular Chemistry- Fundamentals and Applications by Katsuhiko Ariga, Toyoki Kunitake Springer
5. C. E. Harland 1994 Ion exchange theory and practice, 2nd edn, Royal society of Chemistry Cambridge.
6. J. Korkisch 1989 Handbook of ion exchange resins, their application to inorganic chemistry CRC Press, Boca Raton FL.
7. Sulabha K. Kulkarni, Nanotechnology-Principles and Practices, Capital Publishing Co., 2007.
8. Polyoxometalate Chemistry From Topology via Self-Assembly to Applications by Michael T. Pope and Achim Müller, Kluwer Academic Publishers, New York.
9. Advances in Inorganic Chemistry by Rudi van Eldik, Lee Cronin-Polyoxometalate Chemistry, 2017, Zoe Kruze.
10. Nanoparticle Technology for Drug Delivery, Ram B. Gupta and Uday B. Kompella, Taylor & Francis.
11. Metal-Organic Frameworks: Applications from Catalysis to Gas Storage edited by Dr. David Farrusseng, Wiley-VCH.

Learning Outcomes: After completing this course, the student shall

1. understand the types, preparation and applications of nanomaterials. The students utilize this knowledge for their research.
2. Understand the types, preparation and applications of ion exchange resins. The students utilize this knowledge for their research.
3. Understand the basic theory, synthesis and importance of Supramolecular chemistry.
4. know the various supramolecular interactions and host-guest chemistry.
5. The course is specifically design to cater the research need of the department of chemistry, Gujarat University (UGC-SAP, Supramolecular Chemistry) and other university nearby Ahmedabad region such as NFSU, PDPU, CUG, IIT-Gandhinagar.
6. know the MOFs and some terminology of MOFs. The students utilize this knowledge for their research.

SEMESTER - 3 (Inorganic Chemistry)

CHE(I) 502 Catalysis and Organometallic Chemistry

Objective:

To provides basic concept of heterogeneous catalysis and organometallic chemistry. The topic of organometallic chemistry includes synthetic and catalytic aspects of main group organometallic compounds, transition metal organometallic compounds, biological and environmental aspects.

Unit-I	**Heterogeneous Catalysis: Fundamentals and Applications** Introduction, Definition of catalysis, Types of catalysis, Basics of heterogeneous catalysis, advantages of heterogeneous catalysis, supports for heterogeneous catalysis, Catalytic process, Aspects of heterogeneous catalysis in green chemistry, Applications of heterogeneous catalysis	**25%**
Unit-II	**Synthetic and catalytic aspects of main group organometallic compounds** Synthetic applications of main group organometallic compounds as stoichiometric reagents–organolithium, organosodium, organopotassium, organomagnesium, organozinc, organocadmium, organomercury, organoboranes, organoaluminium, organothalium, organosilicon and organotin, Catalytic applications of main group organometallic compounds	**25%**
Unit-III	**Transition metal organometallic compounds as catalysts and synthetic reagents** Catalytic processes involving transition metal organometallic compounds as homogeneous catalysts – hydrogenation, hydroformylation, oxidation, isomerization, dimerization and polymerization of alkenes and alkenes metathesis, Catalytic processes based on carbon monoxide and transition metal organometallic compounds as catalysts, Mechanism of reactions catalyzed by transition metal organometallics, Applications of transition metal organometallic compounds as synthetic reagents	**25%**
Unit-IV	**Biological application and environmental aspects of organometallic compounds** Introduction, Organometallics in medicine, Organometallics in agriculture and horticulture, Organometallics in industry, environmental aspects of organometallic compounds.	**25%**

Reference Books:

1. Modern Heterogeneous Catalysis by Rutger A. van Santen, Wiley-VCH.
2. Heterogeneous Catalysis: Fundamentals and Applications by Julian R.H. Ross, Elsevier.
3. Handbook of Green Chemistry, Green Catalysis, Vol. 2 by Paul T. Anastas, Wiley-VCH.
4. Organometallic Compounds, Vol.1 & 2 by G.E. Coates, M.L.H. Green and K. Wade, Metheun & Co. Ltd. London EC4.

5. Organometallic Compounds by G.E. Coates, John Wiley & Sons, Inc., New York.
6. Organometallic Chemistry by H. Zeiss, Reinhold Publishing Corporation, New York.
7. Organometallic Chemistry by R.C. Mehrotra & Anirudh Singh, New Age International (P) Limited, Publishers, New Delhi.
8. Progress in Inorganic Chemistry, Vol. 1 by F.A. Cotton, Interscience, Pub.Inc., New York.
9. Organotransition Metal Chemistry by John F. Hartwing, University Science Books, Sausalito, California.

Learning Outcomes: After completing this course, the student shall

1. understand the fundamentals and applications of heterogeneous catalysis. The students utilize this knowledge for their research.
2. Understand the preparation and applications of main group OMC.
3. Understand the basics of catalysis and different catalytic reactions promoted by OMC and importance of OMC.
4. know the biological and environmental aspects of OMC.
5. The course is specifically design to cater the research need of the department of chemistry, Gujarat University and other university nearby Ahmedabad region such as NFSU, PDPU, CUG, IIT-Gandhinagar.

SEMESTER - 3 (Inorganic Chemistry)

CHE(I) 503 Spectroscopy

Objective:

The main objective of the course is to make students aware of theoretical aspect of different spectroscopic techniques such as IR, UV, NMR, ESR and mass spectroscopy. Objective is to understand the principles, instrumentation and applications of FT-IR and UV. Objective is to understand the principles, instrumentation, some important terms and applications of 1H & 13C-NMR. Objective is to understand the principles, instrumentation and applications of ESR. Understanding of concepts of Double Resonanace and Fourier transform EPR techniques. Mossbauer spectroscopy and microscopic techniques such as SEM, STF, AFM. Objective is to understand the principles, instrumentation, some important terms and applications of all the techniques. Final objective is to learn structure elucidation of unknown compounds.

Unit-I	**Infrared Spectroscopy:** Theory and Application of FT-IR. Symmetry and shape of AB_2, AB_3, AB_4, AB_5 and AB_6. Modes of bonding of ambidentate ligands. Effect on coordination on ligand Bands, Change in symmetry on coordination. Organomettallic compounds. Metal ligand vibration. **Ultraviolet Spectroscopy** Theory of electronic transition and auxochromes, Woodward-Fieser rules, Characteristic absorptions in various compounds	**25%**
Unit-II	**Nuclear Magnetic Resonance Spectroscopy** ^{1}H Nuclear Magnetic Resonance (^{1}H NMR) spectroscopy, Chemical shifts and factors affecting chemical shifts, Splitting of the signals – spin couplings and coupling constants, Chemical shift equivalence and magnetic equivalence, ^{13}C-NMR spectroscopy, Proton coupled and decoupled ^{13}C NMR spectra, Chemical shifts in ^{13}C NMR spectra and their calculation, ^{13}C-^{1}H coupling constants, ^{13}C–DEPT spectra, Nuclear Overhauser Effect, NMR Spectroscopy of other important spin ½ nuclei, Interpretation of NMR spectra Contact shift and pseudocontact shift. Lanthanide complexes as shift reagents. Double resonance Technique.	**25%**
Unit-III	**Electron Spin Resonance.** Theory of Electron Spin Resonance (ESR) Spectroscopy, Instrumentation, Factors affecting the g-values, Differences between NMR and ESR, Hyperfine interactions, Interpretation of ESR spectra, Applications of ESR,	**25%**

	Survey of EPR spectra of first row transition metal ion complexes, Double Resonance and Fourier transform EPR techniques.	
Unit-IV	**Mossbauer Spectroscopy and Microscopic Techniques:** **(a) Mossbauer Spectroscopy** Basic principle, Spectral parameters and spectrum display. Interpretation of Isomer shift. Application of Technique to the studies of bonding and structure of Fe^{2+} and Fe^{3+} compounds, Sn^{2+} and Sn^{4+} compounds and detection of oxidation states. FAB and electronspray mass spectrometry of metal complexes. **(b) Microscopic Techniques:** Introduction to scanning electron microscopy (SEM), Scanning tunneling microscopy (STM) and atomic force microscopy (AFM); basic principles and theory; instrumentation and operating parameters and applications	**25%**

Reference Books:

1. Spectroscopic Identification of Organic Compounds by R. M. Silverstein and F. X. Webster, 6th edition, John Wiley & Sons.
2. Introduction to Spectroscopy by D. L. Pavia, G. M. Lampman and G. S. Kriz, 3rd edition, Thomson Brooks/Cole.
3. Spectroscopic Methods in Organic Chemistry by D. H. Williams and I. Fleming, 4th edition, Mcgraw–Hill Book Company.
4. Organic Spectroscopy by William Kemp, 3rd edition, Palgrave.
5. Organic Spectroscopy–Principles and Applications by Jag Mohan, 2nd edition, Narosa Publishing House.
6. Spectroscopy of Organic Compounds by P. S. Kalsi, 5th edition, New Age International Publishers.

Learning Outcomes: After completing this course, the student shall

1. Understand the theory, instrumentation and interpretation of FT-IR and UV.
2. know the principles and some terminology of 1H & 13C - NMR. They are able to used shift reagents.
3. understand the principle, instrumentation and applications of ESR.
4. understand the theory, instrumentation important terms of mass spectrometry.
5. With understanding of all four units, students are able to characterization of molecules, which is helpful for their professional and research carrier.

SEMESTER - 3 (Inorganic Chemistry)

CHE(EI) 504 Applications of Inorganic Chemistry in Industry

Objective:

To impart basic knowledge of Inorganic chemistry in Industry. The course includes introduction, synthesis manufacturing process and applications of some pigments, smart materials, corrosion inhibitors and inorganic polymers. These topics are very important and used in industries.

Unit-I	**Pigments** Introduction; Pigments in foods–naturally occurring plant- and animal-pigments; Synthetic food pigments such as Sunset yellow, Allura red, etc.; pigments in plants –raw materials for paints; Physical properties of the pigments in paints; Brief descriptions of the manufacturing process and use of commonly used pigments such as White lead, Zinc oxide, Titanium dioxide, etc.	**25%**
Unit-II	**Smart materials** Ceramics, alloys, gels and polymers. Piezoelectric materials, electrostrictive and magnetostrictive materials, rheological, thermoresponve, pH sensitive halochromic materials, electrochromic materials and smart gels.	**25%**
Unit-III	**Corrosion Inhibitors** Introduction, Types of corrosion Principles of corrosion inhibitors, corrosion as an electrochemical process, Practical aspects of corrosion inhibition, Anion inhibitor properties in neutral electrolytes, some application of corrosion inhibitors (cooling water circulation-once through and open systems, engine radiation & cooling systems, central heating system, refrigeration plants and high chloride systems, water for steam raising, corrosion inhibitors for paint coating plastic linings, alloying for corrosion resistance)	**25%**
Unit-IV	**Inorganic Polymers** Introduction, Classification of inorganic polymers, General properties of inorganic polymers, Characterization of inorganic polymers, Crystalline and amorphous polymers, Solubility parameter, Glass-transition temperature, Modulus-temperature curves, Important inorganic polymers: phosphorus-based polymers, Sulphur-based polymers, Boron-based polymers, Silicon-based polymers, Pre-ceramic Inorganic polymers	**25%**

Reference Books:

1. UHLIGS Corrosion Handbook, R. Winston Revie., Jhon Wiley & Sons JNC.
2. An Introduction to metallic corrosion, U.R. Evans, Cambridge, England.

3.Handbook of Industrial Chemistry, Vol.1 by K.H.Davis, F.S.Berner, CBS Publishers, Bangalore.
4. Comprehensive Coordination Chemistry, Chapter 57, 58.
5. Insight into Speciality Inorganic Chemicals, Chapter 15, by David Thompson, The Royal Society of Chemistry, 1995.
6. New Trends in Green Chemistry, 2nd Edition by V.K.Ahluwalia and M.Kidwai, Anamaya Publishers, 2007.
7. Advanced Inorganic Chemistry Vol. 1, Gurdeep Raj, Krishna Publication Meerut.
8. Inorganic Polymers, 2ndEdition byJ.E. Mark, H.R. Allcock, R. West, Oxford University Press, Inc., New York.
9. Inorganic and Organometallic Polymers by R.D. Archer,Wiley-VCH, Inc.
10. Inorganic Polymers by D.N. Hunter.
11. Modern Aspects of Inorganic Chemistry by H.Emeleus and A.G.Sharpe, Universal Books Stall, New Delhi Routledge & Kegan paul, London.
12. Inorganic Polymers by G.R.Chatwal, Himalaya Publishing House.

Learning Outcomes: After completing this course, the student shall

1. Understand the importance of pigments and their synthesis.
2. know the smart material and applications.
3. understand the types, preparation and applications of corrosion inhibitors. The students utilize this knowledge for their research.
4. Knowledge of coordination polymers open the opportunities in related industries in the state of Gujarat. Which is helpful for their professional and research carrier.
5. With understanding of all four units, students easily absorb in the chemical industries.

SEMESTER - 3 (Inorganic Chemistry)

CHE(EI) 504 Spectroscopy-II

Objective:

The main objective of the course is to make students aware of theoretical aspect of different analytical instrumentation techniques such as thermal methods, X-ray diffraction methods, Electron spectroscopy such as XPS, UPS, AES, Atomic absorption and Flame Emission spectroscopy. Objective is to understand the principles, instrumentation and applications of mass spectrometer, the use of ionization techniques based on application, the basic concepts of Fragmentation Rules and its applications. Final objective is to learn structure elucidation of unknown compounds.

Unit-I	**Thermal and X-ray diffraction methods** (a) **Thermal methods:** Principles, instrumentation and application of TGA, DTA and DSC. (b) **X-ray diffraction Methods:** Production of x-rays and Bragg's equation, instrumentation and application for structural studies	**25%**
Unit-II	**Electron Spectroscopy:** Introduction, principle and theory of electron spectroscopy, Notations, X-ray Photoelectron Spectroscopy (XPS), Ultraviolet Photoelectron Spectroscopy (UPS), Auger Electron Spectroscopy (AES), Instrumentation of electron spectroscopy, Qualitative and Qualitative analysis by electron spectroscopy, Chemical shifts, Unwanted features in electron spectra, Applications of electron spectroscopy	**25%**
Unit-III	**Atomic Absorption/Atomic and Flame Emission Spectroscopy** Absorption of radiation by atoms; equipment: radiation sources (Hollow cathode lamps and electrode less discharge lamps); atomizers (Flame and carbon); wavelength selector and detectors; interferences in atomic absorption spectroscopy; applications and problems: qualitative and quantitative analysis. Introduction to plasma, arc and spark emission spectroscopy; equipment: inductively coupled plasma spectrometer and flame photometer; applications and problems	**25%**
Unit-IV	**Mass Spectroscopy** Theory of Mass Spectroscopy, Instrumentation, Ionization techniques, Mass analyzers, Fragmentations and rearrangements, Interpretation of mass spectra, Determination of molecular formula, Mass spectra of some chemical classes	**25%**

Reference Books:

1. Elements of X-Ray Diffraction (3rd Edition), B.D.Cullity,
2."Principles and Practice of X – Ray Spectrometric Analysis", 2nd edition, Bertin, Eugene, Plenum Press, New York, 1975.
3."An Introduction to X –Ray Spectrometry", Jenkins, Ron, Heyden & Sons, London, 1974.
4. Principles of Instrumental Analysis" by Douglas A. Skoog, 3rd Edition, Holt-Saunders International Edition
5. Principles of Instrumental Analysis by Skoog, Holler and Neiman, Sunders College Publishers (USA).
6. Undergraduate Instrumental Analysis by James W. Robinson, Marcel Dekker, Inc. (Ny.)
7. Introduction to Instrumental Analysis by Robert D. Braun, Pharme Med Press Hyderabad-India.
8. Instrumental Method of Analysis by Willard, Merritt, Jr., Dean and Settle Jr., CBS Publishers and distributors, New Delhi, India.
9. Microscopic and Spectroscopic Imaging of the Chemical State by Michael D. Morris, Marcel Dekker, Inc. (NY.).
10.Instrumental Methods of Chemical Analysis, 24th Edition 2005 by B. K. Sharma, Goel Publishing House, Meerut

Learning Outcomes: After completing this course, the student shall

1. Understand the theory, instrumentation and important terms of TGA and XRD.
2. know the principles and instrumentation and applications of XPS, UPS, AES.
3. understand the principle, instrumentation and applications of AAS.
4. understand the theory, instrumentation important terms of mass spectrometry.
5. With understanding of all four units, students are able to characterization of molecules, which is helpful for their professional and research carrier.

SEMESTER - 3 (Inorganic Chemistry)

CHE(EI) 504 Transition Metal Organometallic Chemistry: Principles to Applications *(Online through SWAYAM)*

Transition Metal Organometallic Chemistry: Principles to Applications

By Prof. P. Ghosh | IIT Bombay https://onlinecourses.nptel.ac.in/noc21_cy36/preview

This course would cover all aspects of Organometallic Chemistry, starting from the principles to its applications.

INTENDED AUDIENCE: All of Chemistry and possibly some of Chemical Engineering students.
PREREQUISITES: UG General Chemistry.
INDUSTRY SUPPORT: Reliance, Dupont, BASF, BAYER, DOW Chemicals.

Summary

Course Status :	Upcoming
Course Type :	Elective
Duration :	12 weeks
Start Date :	26 Jul 2021
End Date :	15 Oct 2021
Exam Date :	24 Oct 2021
Enrollment Ends :	02 Aug 2021
Category :	o Chemistry
Credit Points :	3
Level :	Undergraduate/Postgraduate

This is an AICTE approved FDP course

Course layout
Week 1 :
Lecture 1: History of Organometallic Compounds,
Lecture 2: Polarity and Reactivity of M−C bond
Lecture 3: Reactivity of Organometallic Compounds
Lecture 4: Reactivity of Organometallic Compounds (contd...)
Lecture 5: 18 Valence Electron Rule and Classification

Week 2 :
Lecture 6: 18 Valence Electron Rule and Classification
Lecture 7: Reactivity and types of Organometallic compounds
Lecture 8: sigma- Donor ligands
Lecture 9: Preparation of sigma- alkyl compounds
Lecture 10: Preparation and Properties of sigma- alkyl compounds

Week 3 :
Lecture 11: Properties of sigma- alkyl compounds
Lecture 12: β−elimination in sigma- alkyl compounds
Lecture 13: β−elimination in detail
Lecture 14: TM sigma- alkyl complexes and its application
Lecture 15: TM sigma- alkyl complexes and its application (contd...)

Week 4 :
Lecture 16: C−H activation
Lecture 17: C−H activation in details
Lecture 18: C−H activation in details (contd...)
Lecture 19: Characterization of C−H activation
Lecture 20: Bonding in C−H activation

Week 5 :
Lecture 21: C−C Bond activation
Lecture 22: C−C Bond activation (contd...)
Lecture 23: C−C Bond activation in Details
Lecture 24: Transition Metal Perfluoroalkyl (RF−TM) Complexes
Lecture 25: Preparation of Transition Metal Perfluoroalkyl (RF−TM) Complexes

Week 6 :
Lecture 26: C−F Activation
Lecture 27: Transition Metal Alkenyl/Aryl Complexes
Lecture 28: Transition Metal Aryl Complexes
Lecture 29: Transition Metal Aryl/Alkyne Complexes
Lecture 30: Transition Metal Alkyne/Carbene Complexes

Week 7 :
Lecture 31: Transition Metal Carbene Complexes: Preparations
Lecture 32: Transition Metal Carbene Complexes: Properties
Lecture 33: Transition Metal Carbene Complexes: Reactivities
Lecture 34: Transition Metal Carbene Complexes: Reactivities (contd...)
Lecture 35: Transition Metal Carbene Complexes: Reactivities (contd...)

Week 8 :
Lecture 36: Transition Metal Carbene Complexes: Reactivities (contd...)
Lecture 37: Reactivity of Schrock type Carbene Complexes and Transition Metal Carbynes
Lecture 38: Transition Metal Carbynes: Preparation
Lecture 39: Transition Metal Carbynes: Properties

Lecture 40: Transition Metal Carbynes: Properties (contd...)

Week 9 :
Lecture 41: Properties of Transition Metal Carbynes And Transition Metal Carbonyls
Lecture 42: Transition Metal Carbonyls
Lecture 43: Transition Metal Carbonyls (contd...)
Lecture 44: Transition Metal Carbonyls: Bonding properties
Lecture 45: Transition Metal Carbonyls: Bonding properties (contd...)

Week 10 :
Lecture 46: Transition Metal Carbonyls: Reactivities
Lecture 47: Transition Metal Carbonyls: Reactivity and Carbonyl Metallates
Lecture 48: Transition Metal Carbonyl Hydrides
Lecture 49: Application of Carbonyl Metallates and Metal Halides
Lecture 50: Application of Metal Halides and Metal Alkenes

Week 11 :
Lecture 51: Transition Metal Olefin Complexes
Lecture 52: Transition Metal Olefin Complexes (contd...)
Lecture 53: Transition Metal Olefin Complexes: Reactivity
Lecture 54: Bonding Properties in Olefin Complexes
Lecture 55: Transition Metal Diolefin Complexes

Week 12 :
Lecture 56: Transition Metal Diolefin and Alkyne Complexes
Lecture 57: Transition Metal Alkyne Complexes
Lecture 58: Transition Metal Alkyne Complexes: Reactivity
Lecture 59: Transition Metal Alkyne Complexes: Reactivity (contd...)
Lecture 60: Summary: Transition Metal Organometallic Chemistry: Principles to Applications

Books and references

Elschenbroich (Organometallics), Crabtree (Organometallics)

Instructor bio

Prof. P. Ghosh
IIT Bombay

Dr. Prasenjit Ghosh is a Professor of Inorganic Chemistry at Indian Institute of Technology Bombay (IIT Bombay), India. He received his PhD in bioinorganic chemistry under the supervision of Professor Gerard Parkin from Columbia University, New York, in 1998. Following two post- doctoral stints in the laboratories of Dr. R. Morris Bullock (Brookhaven National Laboratory, 19982001) and Professor Guillermo C. Bazan (University of California, Santa Barbara, 20012003), he joined the Department of Chemistry at IIT Bombay as an Assistant Professor in 2003 and was finally promoted to Professor in June, 2012. He received the CRSI Bronze Medal (2014) of the Chemical Research Society of India and The Distinguished Lectureship Award (2011) of the Chemical Society of Japan among many others in the recent years. He is an Editorial Advisory Board member of the ACS journal Organometallics from 2017 for a three-year period and of Polyhedron since 2011.

Course certificate

The course is free to enroll and learn from. But if you want a certificate, you have to register and write the proctored exam conducted by us in person at any of the designated exam centres.

The exam is optional for a fee of Rs 1000/- (Rupees one thousand only).
Date and Time of Exams: **24 October 2021** Morning session 9am to 12 noon; Afternoon Session 2pm to 5pm.
Registration url: Announcments will be made when the registration form is open for registrations.
The online registration form has to be filled and the certification exam fee needs to be paid. More details will be made available when the exam registration form is published. If there are any changes, it will be mentioned then.
Please check the form for more details on the cities where the exams will be held, the conditions you agree to when you fill the form etc.

CRITERIA TO GET A CERTIFICATE
Average assignment score = 25% of average of best 8 assignments out of the total 12 assignments given in the course.
Exam score = 75% of the proctored certification exam score out of 100
Final score = Average assignment score + Exam score

YOU WILL BE ELIGIBLE FOR A CERTIFICATE ONLY IF AVERAGE ASSIGNMENT SCORE >=10/25 AND EXAM SCORE >= 30/75. If one of the 2 criteria is not met, you will not get the certificate even if the Final score >= 40/100.

Certificate will have your name, photograph and the score in the final exam with the breakup.It will have the logos of NPTEL and IIT Bombay .It will be e-verifiable at nptel.ac.in/noc.

Only the e-certificate will be made available. Hard copies will not be dispatched.

Once again, thanks for your interest in our online courses and certification. Happy learning.

- NPTEL team

SEMESTER - 3 (Inorganic Chemistry)

CHE(I) 505 & 506 PR(PRACTICALS)

Objective:

To impart practical knowledge and skills in inorganic laboratories and synthesis and characterization of various complexes and compounds using modern instrumental techniques. Analysis of alloys, industrial waste and cement includes understandings of standardization of various reagents, buffer solution preparation, decomposition of material etc.

CHE(I) 505 PRACTICALS: Synthesis of inorganic complexes/compounds and their characterization by various physicochemical methods, viz. IR, UV, Visible, NMR, magnetic susceptibility etc. Selection can be made from the following or any other from the existed literature.

1. Cis and trans isomers of $[Co(en)_2Cl_2]Cl$

   J. Chem. Soc., 1960, 4369.

2. Ion-exchange separation of oxidation states of vanadium.

   J. Chem. Educ., 1980, 57, 316; 1978, 55, 55.

3. Preparation of Ferrocene.

   J. Chem. Educ. 1966, 43, 73; 1976, 53, 730.

4. Preparation of triphenyl phosphine PPh_3, and its transition metal complexes.

5. Determination of Cr(III) complexes.

   $[Cr(H_2O)_6]NO_3.3H_2O$; $[Cr(H_2O)_4Cl_2]Cl.2H_2O$; $[Cr(en)_3]Cl_3$; $Cr(acac)_3$

6. Tin(IV) iodide, Tin(IV) chloride, Tin(II) iodide

   Inorg. Synth. 1953, 4, 119

7. (N,N)-bis(salicyldehyde)ethylenediamine $SalenH_2$; and its cobalt complex [Co(Salen)].

   J. Chem. Educ., 1977, 54, 443; 1973, 50, 670.

8. Vanadyl acetylacetonate

9. Reaction of Cr(III) with multidentate ligands, a kinetics experiment.

   J. Am. Chem. Soc., 1953, 75, 5670.

10. Mixed valence dinuclear complex of Mangenese(III, IV).

11. Other new novel synthesis reported in literature time to time.

CHE(I) 506 PRACTICALS: Alloys analysis, Ion exchange, complexometery, industrial waste and cement

1. Analysis of BRONZE
2. Analysis of Solder
3. Analysis of Steel
4. Analysis Aluminum alloy
5. Analysis of Gun metal
6. Capacity of ion exchangers
7. Separation of cations and anions using ion exchangers (3)
8. Analysis of mixtures by complexometery (3)
9. Analysis of Industrial waste
10. Determination of Calcium fluoride, Calcium and Carbonate from Industrial waste
11. Analysis of Cement: (White/Black Cement). Determination of SiO_2, Fe^{+3}, Al^{+3}, Ca^{+2}, Mg^{+2} in a given sample.

Reference Books:

1. Qualitative Chemical semimicroanalysis by V. N. Alexeyev, Mir Publishers Moscow.
2. Vogel's Qualitative Inorganic Analysis by G. Svehla, Orent Longman, New Delhi.
3. Vogel's Textbook of Quantitative Chemical Analysis, 5th edition by G. H. Jeffery, J. Bassett, J. Mendham and R. C. Denney, ELBS Publication, 1996, Chapter 2, 3, 11.
4. Modern Analytical Chemistry, 1st Edition by D. Harvey, The McGraw-Hill Pub, 2000.
5. Instrumental Methods of Analysis, 4th edition by G.W. Ewing, McFraw Hill Ltd., 1970.
6. Physical Methods in Inorganic Chemistry by R. S. Drago, John-Wiley Pub., 1975.

Learning Outcomes: After completing this course, the student shall

1. Understand the synthesis of various complexes.
2. know the practical applications of coordination chemistry, various instrument and characterization.
3. understand the types and applications of ion exchange resins. The students utilize this knowledge for their research.
4. Knowledge of cement and waste analysis allow student to absorb in chemical industries

SEMESTER – 4 (Inorganic Chemistry)

CHE(I) 507 Scientific Writing

- Writing of Research Article/Review Article/Commentary Article/Case Study/ Monograph/Book Chapter/Book Review/Research Proposal or any other scientific article type.
- The student can select any one scientific writing type or research proposal and submit a copy (hard and soft) of the same for internal and external evaluation.
- Evaluation shall be centered around on novelty, relevance, significance, and impact.
- Additional weightage will be given for submission/publishing of any article type in any journal (University journal or a journal that is indexed in the UGC CARE list/Web of Science/ SCOPUS/SCI/SCIE etc.) or a research proposal.

Guidelines for Scientific Writing

Research Article

Presents a full report with new results on a specific topic. Complete experimental details with proper justification. Generally not limited in length, with figures, tables, and references. Format…Title, Authors, Abstract, introduction, experimental, results, discussion, conclusion, acknowledgment, references

Review Articles/Commentary Article

Gives an overview of research in a particular field. It can be on one's own research or any other topic of general and current interest. Organized differently from communications or research articles as it does not have primary experimental data.

Data of existing literature can be presented in a tabular format, graphs, diagrams, figures, charts etc. Should be referenced as thoroughly as possible. Format…Title, Authors, Abstract, introduction, discussion, conclusion, acknowledgment, references

Case Study

This study represents person, group, or situation that has been studied over time. Format depends upon the type of study.

Monograph

Title, Author, Introduction: Reason to select a topic; History, timeline, and Scientific/social significance; Benefits to the scientific community, teaching, and research, Development: Exposition of ideas into paragraphs or chapters.

"Quote that authors endorse these ideas." Conclusion: Status and future perspectives, References: Should be referenced as thoroughly as possible

Book Chapter

Title, Authors, Abstract, Introduction/Background on the topic, Discussion (with subdivisions): Text with tables, figures, charts etc., Summary/Conclusion: Status and future perspectives, References

Book Review

A book review is a thorough description, critical analysis, and/or evaluation of the quality, meaning, and significance of a book, often written in relation to prior research on the topic. Scope/Purpose/Content, Note the Method/Methodology of writing, Critically Evaluate the Contents, Examine the Front Matter and Back Matter, Summarize and Comment.

Research Proposal

Title, Research Problem/Problem Statement, Rational/Purpose of the Study, Review of the Literature, Proposed Research Framework, Research Questions/Proposed Hypothesis, Significance, Proposed Methods and Procedures, Deliverables/Expected Outcomes, Execution timelines, year wise breakup, Financial aspects, References

References

1 *"A Manual for Writers of Research Papers, Theses, and Dissertations",*Kate Turabian, University of Chicago Press, 8th Edition, 2013.

2 "*Concise Guide to Writing Research Papers (Perfect Phrases Series)",*Carol Ellison**,** McGraw-Hill Education; 1st Edition, 2010.

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CHE(I) 508 Report Writing

- Report Writing for Participation and/or presentation (Poster/Oral/Invited talk as applicable) in University/State level/National/International Seminar/ Conference/ Webinar/ Symposium/Workshop/Hands-on training/Software learning of at least 5 (five) days. The sessions must be a minimum of 6 hours per day, in case of seminar/ webinar/ conference/workshop, it is mandatory to participate more than 30 hours in such events. In the case of one day seminar/ webinar/ conference/workshop, it is mandatory to participate in two such events.

- Evaluation will be based on detailed technical report prepared on the conference/seminar/workshop participated and for Poster/Oral presentation, as

applicable.

- Additional weightage will be given for Poster/Oral presentations.

Guidelines for Report Writing

It aims to summarise the most important talks/research presented. It is not usually feasible to attempt comprehensive coverage of the conference. More focus should be on those presentations that are most topical, interesting, or thought-provoking.

Points to consider when writing the report:

- Name of Institute/Department/University that organized the conference
- Title and theme of the conference
- Information regarding number of attendees, where and when it was held (date), name of the convener, organizing secretary etc.
- Include a copy of the brochure
- A brief about the Inaugural Session
- Details of all the technical sessions
- List of main speakers, their position/designation, topic, expertise, and their institutional affiliation
- Highlight research paper(s) or work with major significance and impact
- A brief about the Concluding/Valedictory Session
- Embed the text with photographs wherever possible
- The outcome/summary: Your learning

References

1 *"Writing for Conferences:A Handbook for Graduate Students and Faculty",* Leo Mallette, Clare Berger, Greenwood; Illustrated Edition, 2011.

2 *"The Creative Writing Handbook"*, John Singleton (Editor), Mary Luckhurst (Editor), Red Globe Press; 2nd Edition, 1999.

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CHE(I) 509 Industrial Training and Industry Visit

Guidelines

1. Each student must undergo a minimum of 1-week industrial training under the supervision of a faculty from the concerned department.
2. The industry may be in Ahmedabad, Gujarat or anywhere in India.
3. The training may be obtained at any R&D, QA, QC, Production or any other relevant department on different instrumental techniques or other laboratory equipment.
4. The students must submit a report on the training obtained from the industry which may include (a) introduction about the industry (b) various activities of the industry (c) the process which are used in the industry (d) the products of the industry and (e) summary and conclusion.
5. The report submitted by each student would be assessed by the branch in-charge and the supervising teacher.
6. The student must discuss/present the details of the training through a power point presentation.
7. The industry tour/visit must be of minimum of two days anywhere in India. The industrial tour certificate will be issued by in charge faculty/Head/Principal, while the visit certificate can be from the industry. Report writing and presentation will be similar to Industrial Training.

CHE(I) 510 Professional Chemistry Test (PCT)

Guidelines for PCT

- Prepare questions from the last five years of CSIR-NET Examinations.
- Preparation should be as per sections A, B, and C from the paper format.
- Examination will be based on MCQ based exam will be conducted.
  (Part A maximum 10 out of 15 questions, Part B maximum 13 out of 20 questions and Part C maximum 6 out of 16 questions. If more than the specified number of questions are answered then the first 10, 13 and 16, respectively will be considered for assessment.)
- No negative marks for wrong answers.

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CHE(I) 510 Dissertation

Guidelines for Dissertation/Project Work

1. Each student must carry out a project for a minimum duration of 30 days under the supervision of a faculty from the concerned department.
2. The project can be carried out either in the department or in any other industry, institute or organizations located in Ahmedabad, Gujarat or anywhere in India.
3. The topics of the dissertation can be selected from any of the four branches of chemistry i.e., Organic, Inorganic, Physical or Analytical. The topic can be related to (a)synthesis, purification, characterization, application of organic compounds or (b)metal complexes preparation and applications or (c)physical studies of various systems (d) method development and validation (e) green chemistry (f) nanomaterials preparation and applications (g) functionalized supramolecules (h) electro analytical methods (i)environmental analysis and decontamination or any other related to the subject.
4. Each student must submit a dissertation on the topic of their study comprising of (a) an introduction on the topic along with literature survey and justification for the selection of the topic (b) materials and methods (c) methodology (d) results and discussion and (e) summary and conclusion along with the references.
5. Each student must give a monthly report and a midterm presentation of their work at the department.
6. The student must discuss/present the details of dissertation through a power-point presentation.
7. Dissertation would be examined by the supervising teacher and external examiner.

OR

SEMESTER – IV (Inorganic Chemistry)

CHE (I) 511 PR (Lab Course)