

# University of Rajasthan Jaipur

## SYLLABUS

Pre Ph.D.Course  
(Chemistry)

Examination-2021

*Raj / Vais*  
Dy. Registrar (Acad.)  
University of Rajasthan  
JAIPUR

The PA2A Course (Chemistry)

General information concerning:

Research papers in all the papers are compulsory and two papers are chosen. The other papers will be chosen by the student after the first examination to meet personal needs in the particular research area. Research papers are chosen by the student after the first examination to meet personal needs in the particular research area.

The list of courses and their papers is given below:

Compulsory Papers

PHYS 101 Research methodology (common to all)

PHYS 102 Analysis of published research papers (Liberalism, a short discussion of the history of the subject and the progress of the research)

Elective papers (Any two)

PHYS 201 Synthetic Inorganic Organometallic & Bioorganic chemistry

PHYS 202 Synthetic Organic Chemistry

PHYS 203 Natural Products

PHYS 204 Electrochemistry

PHYS 205 Environmental Chemistry

PHYS 206 Spectroscopy and Photochemistry

All students must be able to carry out laboratory and field studies prior to being accepted for the course. The student may be required to do field work during the course. The student may be required to do field work during the course.

Duration of field work study paper: 70%

Max. marks of field: 50

Total assessment: 20

Total marks: 100

Course fee (PHYS 101) - Research Methodology of Liberalism & History of the Subject

There is no fee for the course. The student is required to pay for the field work during the course. The student is required to pay for the field work during the course.

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**PCHY-C1: Research Methodology (common to all)**

Max. Marks: 100 (80+20)

Time: 3 hrs.

Note: Examiner will set ten questions two from each unit and the candidates will be required to attempt five questions in all selecting at least one question from each unit. All questions will carry equal marks.

**Unit-I**

**12 Hours**

**Scientific Research:** Introduction, Definition, Perception, Objectives and Characteristics of Research.

**Research Design and methodology:** Identification of the problem, Assessing the status of the problem, Components of Research Problem, Research Design, Formulating the objectives, Preparing design (experimental or otherwise), Review of Research Work, devising a research proposal.

**Research Reports & Projects:** Structure and Components of Research Report, Types of Report, Characteristics of a good Research Report, Style of writing the Report – references and bibliography; Structuring the Research Project/Research Proposal; Industrial-institution interaction: Industrial projects, their feasibility reports.

**Research Ethics & Morals:** Issues related to research ethics, plagiarism, collaborative models and ethics, acknowledgements.

**Unit-II**

**12 Hours**

**Scientific Databases and literature resources:** Brief idea of Primary, Secondary and Tertiary Sources of Literature, The Internet and World Wide Web, internet resources for chemistry and pharmaceutical sciences, finding and citing information. Web of Science, Science Citation Index, Chemical Abstracts, PubMed, Infilbnet. Types of Scientific Documents - Journals, Books (Reference Books, authored books, edited books, Text Books), Monographs, Technical reports, Dissertation, etc. **Scientific Writing** - Organization and writing of research paper, short communications, review articles and technical reports, references and bibliography.

**Unit-III**

**12 Hours**

**Data Analysis and presentation data :** Handling Numeric Data - Presenting data in tables, using spreadsheets, word processors, databases and other packages, simple calculations, statistical analysis, data sheets creation, tables and generation of graphs using a spreadsheet and other related softwares. Hints for solving numerical problems. Drawing chemical structures, chemometrics. Application of standard equation drawing software like, Chemdraw, ISIS/Draw, ACD/Chemsketch. Incorporation of chemical structures into word processing documents, presentation graphics, on-line publication, multimedia animations.

**Unit-IV**

**12 Hours**

**Intellectual Property Right**

Patents and patent writing, parts of patent application, characteristics of the disclosure for an invention. IPR ( Intellectual Property Rights), Types, Objectives, Limitations, Agreements, Laws and Government Enforcement, Ethical Consideration.

**Unit-V**

**12 Hours**

**Fundamental Laboratory Techniques :** Basic principles, Health and safety, working with liquids, Basic laboratory procedures I, Basic laboratory procedures II, Principles of solution chemistry, pH and buffer solutions, procedures for neutralization of strong acids and strong bases.

**Chemical safety and Disaster Management:** Handling of hazardous chemicals, incompatible chemicals, flammable solvents, fire hazards in chemical laboratory, toxicity of chemicals, forms of toxic materials. Emergency response: chemical spills, radiation spills, biohazard spills, leaking compressed gas cylinders, fires, medical emergency accident reporting, health effects and first aid. General safety: General safety and operational rules, waste minimization strategies and safety practices for disposal of chemical waste.

**Books & Literature suggested:**

1. Practical Skills in Chemistry, J. R. Dean, A. M. Jones, D. Holmes, R. Reed, J. Weyers and A Jones, Pearson Education Ltd. [ Prentice Hall] (2002)
2. The Craft of Scientific Writing by Michael Alley, (Springer).
3. The Science of Scientific Writing, by G. D. Gopen and J. A. Swan.
4. The ACS Style Guide: A Manual for Authors and Editors, Second Edition Edited by Janet S. Dodd.
5. Research Methodology by R. Panneerselvam, PHI, New Delhi 2005.
6. Research Methods- A Process of Inquiry, Graziano, A.M., Raulin, M.L, Pearson Publications, 7th Edition (2009).
7. Practical Research Methods, by Dawson, Catherine, 2002, UBS Publishers' Distributors New Delhi.
8. Research Methodology- A step by step Guide for Beginners, ( 2nd ed.) Kumar Ranjit, 2005, Pearson Education.
9. How to write and Publish by Robert A. Day and Barbara Gastel, (Cambridge University Press).
10. A Student's Guide to Methodology by Peter Clough and Cathy Nutbrown, (Sage Publications).
11. Research methodology techniques and methods by C L Kothari, New age International Publishers
12. How to Write a Thesis, Murray, R. Tata McGraw Hill, 2nd Edition (2010).
13. Writing For Academic Journals, Murray, R., McGraw Hill International (2009).
14. Writing for Publication, Henson, K.T., Allyn & Bacon (2005).
15. Doing your Research project, Bell J., Open University Press, Berkshire, 4<sup>th</sup> Edition (2005).
16. A Handbook of Academic Writing, Murray, R. and Moore, S., Tata McGraw Hill International (2006).
17. A Hand Book of Methodology of Research – P. Rajammal and P. Devadoss, R. M. M. Vidya Press (1976).

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**PCHY-C2: Analysis of published research papers / scientific literature**

**Maximum Marks:100**

**Dissertation : 50**

**Viva : 30**

**Internal Assessment: 20**

Analysis of published research papers / scientific literature. A short dissertation on review of literature is to be submitted by each student under the supervision of his / her research supervisor.

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**PChy-E 1: Synthetic Inorganic, Organometallic & Bioinorganic Chemistry.**

Max. Marks: 100 (80+20)

EoSE Time: 3 hrs.

Note: Examiner will set ten questions two from each unit and the candidates will be required to attempt five questions in all selecting at least one question from each unit. All questions will carry equal marks.

**Unit-I**

**12 Hours**

**Synthesis, Properties, Structure and Bonding of:** Schiff bases, Azines, Semicarbazones, Thiosemicarbazones, Benzothiazolines, S-Benzyl and S-Methyldithiocarbazoic acid esters, alkoxides, oximes,  $\beta$ -diketones, carboxylic acids and their metal complexes.

**Unit-II**

**12 Hours**

**Green Synthesis:** Basic principles of green chemistry, green chemistry in day-to-day life, green reagents, green catalysts, microwave induced green synthesis, ultrasound assisted green synthesis, biocatalysts in green synthesis, versatile ionic liquids as green solvents, synthesis involving basic principles of green chemistry: some examples, green chemistry in sustainable development.

**Unit-III**

**12 Hours**

**Organometallic Compounds:** Definition, Classification, nature of carbon-metal bond, methods of preparation, general properties, stability, cyclopentadienyl complexes, arene transition metal complexes, structures, catalytic properties and applications.

**Unit-IV**


**12 Hours**

**Nano and Composite Materials:** Definition, nanoscale regime, nano particles, nanoporous materials, gas phase cluster, condensed phase nano particles, inorganic nanoparticles, nanoparticle preparation by alkali metal reduction method, zeolite method and sol-gel method.

**Unit-V**

**12 Hours**

**Basic Biochemical Methods:** Fundamental of inorganic biochemistry, essential and non essential elements in biosystems, structure and function of metalloproteins in electron transport processes, cytochromes and iron-sulfur proteins, flavoproteins and synthetic models, orientation, units in biochemistry, calibration of volumetric glassware, introduction to biochemical instrumentation. Care and handling of instruments, colorimetry and spectrophotometry.

  
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## PCHY-E2: Synthetic Organic Chemistry

Max. Marks: 100(80+20)

EoSE Time: 3 hrs.

Note: Examiner will set ten questions two from each unit and the candidates will be required to attempt five questions in all selecting at least one question from each unit. All questions will carry equal marks.

### Unit-I

12 Hours

**Stereochemistry** : Introduction, Absolute asymmetric synthesis, Asymmetric induction - Stereospecific and Regiospecific synthesis - Cram's rule. Concept of dynamic enantiomerism. Principle of stereo selectivity, 1,2- and 1,3-asymmetric induction, acyclic stereoselection, distereoselection in cyclic systems. Enantioselective synthesis: Enantioselective hydroboration, hydrogentation, epoxidation, enantioselective synthesis via hydrazones.

**Disconnection approach of synthesis** : Introduction, synthetic strategies of 1,2- and 1,4-difunctionalised compounds. Group disconnection, Umpolung Strategies, functionalisation of carbonyl compounds. Synthetic approach to cyclic systems. Retrosynthetic and reconnection strategies.

### Unit-II

12 Hours

#### Reagents and Reactions:

Application of following reagents with specific examples - Organoboron reagents (IBBN, CATB, IpC2BH, PINB), Organosilicon compounds, Triflates. Trimethylsilyl iodide, Bakers yeast, Hypervalent iodine, Phase transfer catalysts, Lithium dimethylcuprate, Lithium diisopropylamide (LDA), Dicyclohexyl carbodiimide (DDC), 1,3-Dithiane, DDQ, Heck, Vilsmyer, Mukaiyama and McMurray reactions and Suzuki and Sonogashira coupling.

**Protecting groups**: Hydroxy, carbonyl, amines, carboxylic etc. Multistep synthesis, protection and deprotection of functional groups with examples.

### Unit-III

12 Hours

#### Green Chemistry

Basic principles of green chemistry, application of non-conventional techniques in organic synthesis and natural products (ultrasonic, microwave and electrochemical synthesis). Solid state synthesis and synthesis under solvent free conditions. Use of ionic solvents, biocatalysts, nanoparticles etc.

### Unit-IV

12 Hours

**Heterocycles**: IUPAC nomenclature. Heterocyclic synthesis (cyclization and cycloaddition reactions). The Chemistry of the following ring systems: Synthesis, reactions and applications. Three-membered rings, Aziridines Four-membered rings, Azetidines and their 2-oxo derivatives. Indoles, Five-membered rings containing two heteroatoms. Cornforth rearrangement, Reaction with singlet oxygen, Isoxazoles, Boulton-Katritzky rearrangement, photoisomerizations. Pyrazoles, Rearrangement to imidazoles, Imidazoles, acidity of C-2 hydrogen, Catalyst for ester hydrolysis. Six-membered rings- Pyrimidines- ANRORC mechanism in Nucleophilic substitution.

### Unit-IV

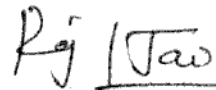
12 Hours

**Enzymes and Mechanism of Enzyme Action**: Classification, isolation and purification. Kinetics of enzyme action-Michaelis-Menten equation. Enzyme inhibition. Co-enzyme Chemistry: Cofactors as derived from vitamins, co-enzymes. Structure and biological functions of coenzyme A.

**Molecular Recognition** : Fullerenes : as host as well as guest , enzyme modeling using an artificial host frame work, cyclodextrins as esterase mimics, functionalized cyclodextrins, chiral corands.

**Books recommended:**

1. Stereochemistry of Organic Compounds by D. Nasipuri.
2. P. S. Kalsi, Stereochemistry: Conformation and Mechanism, 7<sup>th</sup> edition, New Age International Publisher Ltd, New Delhi, 2009.
3. Designing Organic Synthesis by S. Waren.
4. Asymmetric Synthesis Ed. J, D. Morrison, vol. 1-5. Academic Press.
5. Green Chemistry by M. Kidwai and V. K. Ahluwalia
6. Comprehensive Heterocyclic Chemistry II by A. R. Katritzky and C. W. Rees.
7. Heterocyclic Chemistry by T. L. Gilchrist.
8. Wilson and Gisvold's Text Book of organic medicinal and pharmaceutical chemistry.
9. Advanced Organic Chemistry, by Jerry March, John Wiley (2001).
10. Organic Chemistry, by R.T. Morison and R.N. Boyd
11. University Chemistry, Vols II & III by C.P. Murthy, S.F. Mehidi Ali and P.K. Dubey, New Age International, New Delhi.
12. Organic Chemistry, Vol.I, by S.M.Mukherji, S.P. Singh and H.P. Kapoor, Wiley Eastern Ltd., New Delhi,

  
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### PCHY-E3: Natural Products

Max. Marks: 100(80+20)

Time: 3 hrs.

Note: Examiner will set ten questions two from each unit and the candidates will be required to attempt five questions in all selecting at least one question from each unit. All questions will carry equal marks.

#### Unit-I

12 Hours

**Novel herbal formulations** : Phytosomes, Liposomes, Microspheres, novel vesicular herbal formulations etc. Standardization of herbal drugs/formulations

#### Unit-II

12 Hours

**Extraction Techniques** : Conventional methods of extraction of plant material, introduction to Super critical fluid extraction, microwave extraction and ultra-sound extraction methods

#### Unit-III

12 Hours

**Isolation Methods**: Column and Flash chromatographic methods for the separation of alkaloids, steroids, terpenoids and flavonoids

#### Unit-IV

12 Hours

**Purification Technologies** : Purification and separation of secondary metabolites by using TLC, HPTLC and HPLC

#### Unit-V

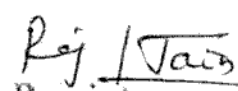
12 Hours

**Assessment of Plant material and regulatory guidelines for herbal Drugs**

WHO Guidelines for assessment of crude drugs, Evaluation of identity, purity, and quality of crude drugs. Determination of pesticide residue Determination of Micro-organisms Determination of Arsenic and heavy metals. Herbal Drug Regulatory affairs Role and importance of national and international regulatory bodies in assessment of quality of herbal drugs and formulations.

#### References

1. Flash chromatography on cartridges for the separation of plant extracts: Rules for the selection of chromatographic conditions and comparison with medium pressure liquid chromatography Petra Weber.et.al, Fitoterapia, Volume 82, Issue 2, March 2011, Pages 155-161
2. Flash Column Chromatography Guide - MIT OpenCourseWare
3. [https://ocw.mit.edu/courses/chemistry/5.../MIT5\\_301IAP12\\_FlashHandout.pdf](https://ocw.mit.edu/courses/chemistry/5.../MIT5_301IAP12_FlashHandout.pdf)
4. HPLC e-Book - Lab-Training.com
5. [lab-training.com/wp-content/uploads/2014/11/HPLC-E-Book.pdf](http://lab-training.com/wp-content/uploads/2014/11/HPLC-E-Book.pdf)
6. Handbook of HPLC, Second Edition - CRC Press Book
7. <https://www.crcpress.com/Handbook-of-HPLC-Second.../p/book/9781574445541>
8. High-Performance Thin-Layer Chromatography (HPTLC), Man Mohan Srivastava, Springer

  
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**PCHY-E4: Electrochemistry**

Max. Marks: 100(80+20)

Time: 3 hrs.

Note: Examiner will set ten questions two from each unit and the candidates will be required to attempt five questions in all selecting at least one question from each unit. All questions will carry equal marks.

**Unit-I**

**12 Hours**

**Electro-analytical Techniques:** Polarography:- Introduction and Basic Principles, Polarographic cell, Half wave potential and its significance. DME, SCE, Carbon paste electrode. Types of current:- diffusion current, migration current, kinetic current, catalytic current, limiting current.

**Volammetry:** Principle and Application. Cyclic volammetry, square wave volammetry, stripping volammetry, coulometry, applications of these techniques in Electro-organic synthesis, Electroanalysis of therapeutic compounds (quantitative and qualitative) and analytical method validation of drugs.

**Unit-II**

**12 Hours**

**Electrocatalysis:** Nano materials:-Definition, method of preparation. Properties of nanoparticles:- Physico-chemical and optical, electrical and electronics properties. Application of nanostructured materials gold, silver and Pt Nanomaterials: General properties and applications Electrocatalysis of alloys and bimetallic nanostructured materials.

**Unit-III**

**12 Hours**

**Electrochemical Energy Conversion:** Nickel- Cadmium battery, Silver-Zinc cells, Dry cells, Fuel cells- the important quantity in electricity storage- electricity storage density- energy density, the Lead acid storage battery.

**Unit-IV**

**12 Hours**

**Bio-electrochemistry :** Biosensors, bioelectrocatalysis, electrocatalysis of nanostructured materials in Biological systems, electrochemical mechanism of nervous system, enzymes as electrodes

**Unit-V**

**12 Hours**

**Technological aspects of electrochemistry:** Corrosion and the stability of metals, the mechanism of the corrosion-thermodynamics and the stability of metals. The corrosion current and the corrosion potential, the influence of air and H upon the rate of corrosion. Passivation: the transporataion from a corroding and unstable surface to a passive and stable surface-the mechanism of passivation.

**Books recommended:**

1. J.O.M. Bockris and A.K.N. Reddy, Modern electrochemistry(Vol.2) Plenum press, New York, 1990.
2. Philip H.Reiger, Electrochemistry, Prentice-Hall, Inc., New Delhi, 1987.
3. Christophor M.Brett, Anamavia Oliveiro and Brett, Electrochemistry, 1987.
4. Pinciples, methods and applications, Oxford University press, Lodon, 1993.
5. Techniques of Electroanalytical cemistry P.T. Kissinger (Marcel-Dekkar)

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## PCHY-E5: Environmental Chemistry

Max. Marks: 100(80+20)

Time: 3 hrs.

Note: Examiner will set ten questions two from each unit and the candidates will be required to attempt five questions in all selecting at least one question from each unit. All questions will carry equal marks.

### Unit-I

12 Hours

**Chemistry of Air Pollution-I:** Introduction to environmental pollution; Concept, nomenclature and segments; Composition of atmosphere; Pollution of atmosphere; Types of air pollutants; Oxides of Carbon, Sulphur, Nitrogen and Hydrocarbons etc; Effect on health and environment; Green house effect, Acid rain and Photochemical smog.

### Unit-II

12 Hours

**Chemistry of Air Pollution-II:** Effect of Ozone on Health & Environment; Chlorofluorocarbons; Effect of Gasoline on air pollution; Presence of Lead in the atmosphere; Reducing toxic emission from the fuel combustion in vehicles; Control of NO emission; Catalytic control device for automobiles.

### Unit-III

12 Hours

**Chemistry of Water Pollution:** Environmental role of water; The Hydrological cycle of water; Classification of water pollutants; Measurement of BOD, COD, TOC; Waste chemicals; Oil spills, Heavy metals; Waste water treatment - Primary, Secondary ( Aerobic & Anaerobic ) and Tertiary treatments.

**Chemistry of Soil Pollution:** Soil pollution; Classification of Soil Pollutants; Source and Classification of Solid Waste; Disposal of Solid Waste on land and sea; Techniques of recycling of Solid Waste.

### Unit-IV

12 Hours

**Pollutants from Industry:** Polymers and Plastics; Sugar and Distillery; Drugs and Pharmaceuticals; Paper and Pulp; Metallurgical industries; Nuclear Power Plants Chernobyl and Minimata disasters.

**Pesticide pollution:** Classification of Pesticides; Environmental implication of Pesticides; Alternate methods of Pest Control; Control methods of Pesticide Pollution; Bhopal gas disaster.

**Water Treatment:** Characteristics of Municipal water; Stages involved in the purification of drinking water; Removal of micro-organisms; Break-point chlorination; Desalination of Brakish water; Electro dialysis; Reverseosmosis; Chemical analysis of water; Estimation of Free Chlorine; Dissolved oxygen; Alkalinity of water.

### Unit-V

12 Hours

**Analytical methods:** Environmental evaluation- Applications of the following methods for measurement of environmental condition; Atomic Absorption Spectroscopy, GC-MS and Chemical methods.

#### Books recommended:

1. "Engineering Chemistry", 15th Edition, by P.C.Jain and Monika Jain, Dhanpat Rai Publishing Company, New Delhi (2005)
2. "Environmental Chemistry", by V.P. Kudesia, Pragathi Prakashan, Meerut, (2003).
3. "Fundamental Concepts of Environmental Chemistry", by G.S. Sodhi, Narosa Publishing House Pvt. Ltd., New Delhi, (2002).
4. "A Text Book in Environmental Science", by V. Subramanian, Narosa Publishing House Pvt. Ltd., New Delhi, (2002).
5. "Environmental Chemistry", by A.K. De, New Age International Ltd. New Delhi, (2003).
6. "An Introduction to Environmental Pollution", by B.K. Sharma and H. Kaur, Goel Publishing House, Meerut, (1999).
7. "Environmental Chemistry", by S.K. Banerji, Prentice – Hall of India, New Delhi, (1999)

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## PCHY-E6: Applications of Analytical Spectroscopic

Max. Marks: 100(80+20)

Time: 3 hrs.

Note: Examiner will set ten questions two from each unit and the candidates will be required to attempt five questions in all selecting at least one question from each unit. All questions will carry equal marks.

### UNIT I

12 Hours

#### Introduction to IR, UV Spectroscopy:

UV Spectroscopy: Absorption laws, effect of solvents on transitions, UV spectra of dienes, polyenes, carbonyl compounds and  $\alpha,\beta$ -unsaturated carbonyl compounds. Woodward's rule and its application. Steric effect on coplanarity.

IR Spectroscopy: Hook's law, vibration modes. Factors effecting fundamental vibration. Absorption of common functional groups, electrical and steric effects, effects of Hydrogen bonding. Fingerprint region and interpretation of IR spectra.

### UNIT-II

12 Hours

$^1\text{H}$  NMR spectroscopy: Double Resonance experiments; relaxation; Multipulse experiments; Nuclear Overhauser effect; Interpretation of spectra, chemical shift, shielding mechanism and anisotropic effects. Second order spectrum and analysis of AB, AMX and ABX systems. Simplification of Complicated Spectra: Aromatic induced shifts spin decoupling, spectra at higher fields. Hindered rotation and rate products.

### UNIT-III

12 Hours

$^{13}\text{C}$ MR Spectroscopy: General considerations, chemical shift, coupling constants. Nuclear Overhauser effect. Spin-spin, spin-lattice relaxations. Off resonance decoupling. DEPT. Interpretation of  $^1\text{H}$  and  $^{13}\text{C}$  NMR spectra. Introduction to 2D NMR: Techniques like, COSY, HSQC, HMBC, NOESY, ROSEY, etc.

### UNIT-IV

12 Hours

Mass Spectrometry: Introduction, ion production. Eland C1, techniques fragmentation, factors influencing ion abundance, single and multiple bond cleavage, doubly charged ions rearrangements, cleavage associated with common functional groups. Mc Lafferty rearrangement. molecular ion peak, metastable ion peak, Nitrogen rule and interpretation of mass spectra, HRMS. Structure elucidation based on spectroscopic data.

### UNIT V

12 Hours

Introduction to application of Techniques like X-ray, LCMS, GCMS, HPLC.