

**DEPARTMENT OF CHEMISTRY  
KOHIMA SCIENCE COLLEGE  
JOTSOMA, NAGALAND**

**SYLLABUS  
FOR  
Ph.D. COURSE WORK  
IN  
CHEMISTRY**

**Department of Chemistry**  
**Kohima Science College, Jotsoma**  
*(An Autonomous Government PG College)*  
 Kohima, Nagaland

Syllabus for Ph.D. Course work

(One semester duration with a total of 16 credits)

The schedule of papers prescribed will be as follows:

Semester	Course Code	Course Title	Maximum Marks	Credit
I	CHEM – 01	Research methodology	100	4
	CHEM – 02	Chemistry (General)	100	4
	CHEM – 03	Elective Paper (anyone from the following)	100	4
	CHEM- 04	Literature review, Report writing and Presentation	100	4
			400	16
General (Chemistry):		Advanced instrumental methods of analysis		
Elective Papers:		A. Advanced topics in Physical Chemistry B. Advanced topics in Environmental Chemistry C. Advances in Chemistry		
Distribution of marks for CHEM- 04:		<ul style="list-style-type: none"> <li>▪ Review of Literature – 30 marks</li> <li>▪ Report Writing – 40 marks</li> <li>▪ Seminar – 30 marks</li> </ul>		

- ❖ **Courses CHEM-01, Course CHEM-02 and Course CHEM-04 are compulsory.**
- ❖ **Elective course (CHEM-03) will be offered on availability of research position in the department. More elective papers will be introduced in the coming years depending upon the availability of the expertise of the supervisors.**

## CORE COURSES:

### CHEM – 01

## Research Methodology

### Unit I

Research Methodology: Introduction- Meaning of Research- Objectives of Research-Types of Research- Research Approaches-Significance of research- Research Methods Vs Methodology- Research and Scientific Methods-Research Process – Criteria for good Research- Problems encountered by researchers in India. The Ethics of Scientific Research: Values, Principles and Plagiarism.

### Unit II

Defining Research Problem, Hypothesis. What is a Research problem- Selecting Research Problem-Necessity of Defining the problem- Techniques involved in defining a problem Research Design Meaning-Need for Research Design-Features of Good Design- Concepts related to Research Design-Different Research Designs.

### Unit III

Data Collection and Data Preparation - Data Collection: Introduction-Experiments and Surveys-Collection of Primary Data-Collection of Secondary data- Secondary data-Selection of Appropriate methods for Data collection-case study methods-Data Preparation process.

### Unit IV

Statistics: Measures of Central Tendency- Measures of Dispersion-Measures of Skewness- kurtosis-Measures of Relationships Associations in case of Attributes- Index numbers measure-Time series Measures.

### Unit V

Interpretation and Report Writing: Meaning of interpretation-techniques on interpretation- precautions in interpretation-Significance of Report writing-Different steps in report writing- Layout of report research-types of reports-oral presentation- mechanics of writing a research report-Plagiarism and Research Ethics.

### **Books:**

1. Gopal Lal Jain; *Research Methodology, Methods, Tools and Techniques*; 2<sup>nd</sup> Ed., 2003, Mangal Deep Publications, Jaipur.
2. C.R Kothari, Gaurav Garg: *Research Methodology*, New Age International publishers Ltd., 2014.
3. S.C. Sinha and A.K. Dhiman, *Research Methodology*, 2002, Ess Ess Publications, New Delhi.
4. S.L. Jat, N.P. Agarwal, M.S. Poonia, *Research Methodology*, 2007, Indus Valley Publications, Jaipur.
5. V.K. Jain, *Basic Programming with Applications*, Tata McGraw Hill, 1995.

**CHEM – 02**  
**ADVANCED INSTRUMENTAL METHODS OF ANALYSIS**

**Unit I**

**X-ray diffraction and X-ray Fluorescence:**

Introduction, Principle, instrumentation and applications of XRD and XRF.

**Unit II**

**Thermal methods:**

Principle and instrumentation of Thermogravimetry, Differential Thermal Analysis, and Differential Scanning Calorimetry Applications with reference to the inorganic and organic compounds.

**Unit III**

**Atomic absorption and Atomic emission Spectroscopy:**

Principle, instrumentation and Applications. Chemical and spectral interferences in atomic spectroscopy. Flameless technique-determination of mercury.

**Unit IV**

**Electrochemical sensors and measurements:**

Formal Potential, factors affecting formal potential. Ion- selective electrodes: principle, types and applications.

Voltametry: Principle of polarography, residual current, migration current, diffusion current, half-wave potential, Ilkovic equation, instrumentation, qualitative and quantitative analysis of inorganic ions Anode Stripping Voltametry: Principle, instrumentation and applications.

**Unit V**

**Spectroscopy Techniques:**

Theory, instrumentation and applications of IR, NMR, LC-MS, GC –MS and ICP-MS.

**Books:**

1. Hobart H. Lynne, L. Willard, Merit Jr. and John A Dean; *Instrumental Methods of Analysis*; CBS Publishers and Distributors, 2012
2. Jack Cazes; *Analytical Instrumentation Handbook*; Third Edition CRC press, 2004.
3. Douglas A Skoog, Brooks Cole; *Principles of Instrumental Analysis*, 1997.
4. Sivasankar; *Instrumental Methods of Analysis*; Oxford university press, 2012
5. Frank A Settle; *Handbook of Instrumental Techniques for Analytical Chemistry*; Prenticehall, 1995.
6. G.M. Barrow; *Molecular Spectroscopy*; McGraw Hill, Tokyo, 2002.
7. William Kemp; *Organic Spectroscopy*; 3<sup>rd</sup> Edition Macmillan Press Ltd; London, 2011
8. Y.R. Sharma; *Elementary Organic Spectroscopy*; S Chand; New Delhi, 2010

## ELECTIVE PAPERS:

### CHEM– 03 (A)

#### ADVANCED TOPICS IN PHYSICAL CHEMISTRY

##### Unit I

###### **Analysis of Kinetic Data:**

Calculation of rate constant from concentration methods when the final value is unknown-propagation of errors – linear least squares regression – non-linear least squares regressions.

##### Unit II

###### **Accuracy in rate constant measurements:**

Measurements of rates – Simplification of experimental kinetics – kinetic scheme: Model Building – Kinetic Equivalence of rate terms – Microscopic reversibility and detailed balance.

##### Unit III

###### **Mechanism of acid – base catalysis :**

Catalysis by transition metal ions and their complexes. Kinetic models for micelle catalysed reactions - pseudo phase model, Piskiwicz model, Berezin model.

##### Unit IV

###### **Fundamental Principles of Irreversible Thermodynamics:**

Open Systems – Evolution of Criteria of Conservation Mass of energy – compared to closed systems – Entropy flow of open systems – Microscopic reversibility and Onsagar relations.

##### Unit V

###### **Elements of Statistical Mechanics:**

Micro and Macro States – Classical distribution Law – Quantum Statistics – Bose – Einstein, Fermi – Dirac Statistics – Conditions for the applicability of Maxwell – Boltzman Statistics – Fermi Energy of Metals, Free electron models (Electron gas concept) – Electronic heat capacity of metals – Fermi Energy levels – Super conductivity and various theories of super conductivity – Negative absolute temperature – Evaluation of partition functions – translational, rotational, vibrational, electronic and nuclear partition functions – statistical evolution of thermodynamic function – energy – Heat capacity – Entropy – free energy.

###### **Books:**

1. Kenneth A. Connors Wiley; *Chemical Kinetics – The study of Reaction Rates in solution*; Wiley-VCH; 1 edition ( 1990).
2. K.J. Laidler; *Chemical Kinetics*; Pearson Education India; 3 edition (2003).
3. Richard E. Dickerson, Benjamin-Cummings; *Molecular thermodynamics*; Publishing Co., Subs. of Addison Wesley Longman, US (1969).
4. S. Glasstone; *Thermodynamics for Chemists*; Read Books (2007).
5. Vojtech Fried; *Physical Chemistry*; Pearson College Div (1977).

## CHEM-03 (B)

### ADVANCED TOPICS IN ENVIRONMENTAL CHEMISTRY

#### Unit I

##### **Air Pollution:**

Composition of Atmosphere, Air quality standards, Types of air pollution, Effect of air Pollutants on man & environment, Chemical & Photochemical reactions in atmosphere; Ozone chemistry, Nitrogen oxides, Sulphur Dioxide, PAN sampling of air, Analysis of The following pollutants: Carbon monoxide, Oxides of nitrogen, Oxides of Sulphur, Particulate matter, Analysis of hydrogen sulphide and analysis of hydro carbons.

#### Unit II

##### **Water Pollution:**

Water Physical and chemical properties, Water pollution; Sources, Eutrophication and Water and quality standards. Types of Pollutants, Sampling and preservation of water and waste water, Analysis of the following in the Drinking water; Hardness, Alkalinity, DO, BOD, COD, Chlorides ammonia, Nitrate and Nitrite, Sulphate; Phosphate, Metals like –  $\text{Fe}^{2+}$ ,  $\text{Mn}^{2+}$ ,  $\text{Pb}^{2+}$ ,  $\text{Ni}^{2+}$  and Cr(VI) and Organics – Phenol.

#### Unit III

##### **Soil Pollution:**

Composition of soil, Inorganic and Organic components in soil, Micro and Macro Nutrients in soil, Sources of soil pollution, Pollutants in soil, Sampling of soil, Analysis of soil – C.E.C, Organic carbon, Chlorides and alkali and alkaline earth metals like  $\text{Na}^+$ ,  $\text{K}^+$  and  $\text{Ca}^{2+}$ .

#### Unit IV

##### **Chemical Toxicology:**

Bio chemical effects of the following, Calcium, Lead, Mercury, Arsenic, Cyanide, Pesticides, Carbon monoxide, Nitrogen oxide and Sulphur dioxide.

#### Unit V

##### **Pollutants: their sources, Degradation and fate in the environment**

(a) Organophosphate and Organochlorine pesticides: DDT, BHC, Parathion and Malathion. (b) Surfactants (c) Fertilizers (d) Xenobiotics (e) Phenols

##### **Books:**

1. Collin Baird, Michael Cann; *Environmental Chemistry*; W. H. Freeman; 4<sup>th</sup> edition (2008)
2. Stanley Manahan; *Environmental Chemistry*; CRC Press; 10 edition (2017).
3. James Girard, Jones & Bartlett Learning; *Principles of environmental chemistry*, 3<sup>rd</sup> edition (2013)

4. Harold F. Hemond, Elizabeth J.Fechner, *Chemical fate and transport in the environment*; Academic Press; 3rd edition (2014)
5. Daniel Vallero; *Fundamentals of Air Pollution*; 5<sup>th</sup> Edition, Academic Press, 2014.
6. Anil Kumar De, *Environmental chemistry*; Wiley Eastern Ltd, 2003.

## CHEM – 03 (C)

### ADVANCES IN CHEMISTRY

#### Unit I

##### **CHEMICAL DYNAMICS AND SPECTROSCOPY:**

Kinetics of Unimolecular reactions; the Lindemann-Hinshelwood Theory of Unimolecular reactions; the Rice-Ramsperger-Kassel-Marcus Slater Theory of Unimolecular Reactions Basic principles of photoacoustic spectroscopy; and applications of photoacoustic spectroscopy in the studies of medicines and biological systems.

Basic principles of UV-Visible spectrophotometer and its applications.

#### Unit II

##### **REAGENTS IN ORGANIC SYNTHESIS**

Pyridinium chlorochromate, Pyridinium fluorochromate, Hydrogen Peroxide, Tetra-n-butyl ammonium permanganate, N-Bromosuccinimide, TBATB, Ruthenium tetroxide, SeO<sub>2</sub>, Ag<sub>2</sub>CO<sub>3</sub>, Prevost's reagent, thallium (III) nitrate, Ceric ammonium nitrate, Tetrapropylammonium perruthenate (TPAP).

Aluminium alkoxides, Li(C<sub>2</sub>H<sub>5</sub>)<sub>3</sub>BH, Lithium hydridoalkoxy aluminates, DIBAL, NaBH<sub>3</sub>CN, Trialkylborohydride, TiCl<sub>3</sub>, BBN, Zn-HCl, Trialkyl Silanes, Trialkyl tin hydride.

Principle of protection of alcohol, amine, carbonyl, carboxyl groups, phenol, diol and pyrroles.

#### Unit III

##### **GREEN CHEMISTRY**

The current status of chemistry and the environment; What is Green Chemistry and why chemists should pursue the goals of green chemistry; Tools of Green Chemistry; Limitations and Obstacles; Principles of Green Chemistry; Evaluating the effects of Chemistry; Future trends in Green Chemistry

#### Unit IV

##### **INTERACTION OF RADIATION WITH MATTER**

Electromagnetic radiation interaction with matter, photoelectric effect, Bremsstrahlung, Compton Effect, Pair production, Neutrons Positive ions interaction, linear energy transfer (LET), stopping power for different ions in different materials,

Theories used for track formation: Ion explosion model, thermal spike model, etch rates, bulk-etch rate, track-etch rate.

#### Unit V

##### **Advance NMR Techniques (Basic knowledge)**

Two dimension NMR spectroscopy; NOISY, DEPT, INEPT terminology.

##### **Carbon-13 NMR Spectroscopy**

Chemical shift (aliphatic, olefinic, alkynes, aromatic, heteroaromatic, carbonyl carbon), <sup>13</sup>C coupling constants,



### Reference Books:

1. W. Carruthers; *Modern methods of Organic synthesis*, Cambridge University Press.
2. L.A. Paquette; *Handbook of Reagents for Organic synthesis* (Four volumes) John Wiley & Sons, 2001.
3. J. March; *Advanced Organic Chemistry*, Wiley-Interscience.
4. J. Clayden, N. Greeves, S. Warren and P. Wothers; *Organic Chemistry*, Oxford University Press.
5. P.R. Jenkins; *Organometallic Reagents in Synthesis*, Oxford University Press.
6. B. P. Mundy and M. G. Ellerd; *Named Reactions and Reagents in Organic Synthesis*, John Wiley & Sons, 1988.
7. M. B. Smith; *Organic Synthesis*, McGraw Hill Inc, 1994.
8. G. Friedlander, J.W. Kennedy and J.M. Mill; *Nuclear and Radiochemistry*, Wiley International, 2<sup>nd</sup> Edition, 1994.
9. H.J. Arnika; *Essentials of nuclear chemistry*, Wiley Eastern, 4<sup>th</sup> Edn. 1995.
10. Keith J. Laidler; *Chemical Kinetics* (Third Edition 2006), Publisher: Pearson Education (Singapore) Pvt. Ltd, Indian Board, 482, F.I.E, Patparganj, Delhi-110 092, India.
11. Mool Chad Gupta; *Atomic and Molecular Spectroscopy*, 2<sup>nd</sup> Edition 2004, New Age International Pvt. Ltd Publisher.
12. Michael Hollas; *Modern Spectroscopy*, John Wiley, 2003.
13. G.M. Barrow; *Molecular Spectroscopy*, McGraw Hill, Tokyo, 2002.
14. M. Chanda; *Atomic Structure and Chemical bond including molecular Spectroscopy*, 3<sup>rd</sup> Edition-1991.
15. N. Sathyamuthy (Ed); *Reactive Dynamics*, Narosa, Publishing House, 2001.
16. Eyring, S.H. Lin and S.M. Lin; *Chemical Kinetics*, John Wiley, 1992.
17. Banwell-Sundaments; *Molecular Spectroscopy*, Tata Mc Graw Hill 1991.
18. R.M. Silverstein, G.C. Rassler and T.C. Morill- *Spectrometric Identifications of Organic compounds*, John Wiley, 1991.