

Department of Chemistry Scheme and Syllabus for Additional Subjects for Eligibility as Trained Graduate Teacher (TGT) for the students of Dual degree B.Sc. (Hons) -M.Sc. Programme in Physics/ Mathematics (w.e.f. Session 2025-26)



Guru Jambheshwar University of Science & Technology Hisar-125001, Haryana

(A<sup>+</sup> NAAC Accredited State Govt. University)



# **DEPARTMENT OF CHEMISTRY** GURU JAMBHESHWAR UNIVERSITY OF SCIENCE & TECHNOLOGY, HISAR

# Proposed Scheme and Syllabus for Additional Subjects for Eligibility as Trained Graduate Teacher (TGT) for the students of Dual degree B.Sc. (Hons) -M.Sc. **Programme in Physics/ Mathematics** (w.e.f. Session 2025-26).

Type of Course	Course Code	SEMESTER-III							
		Nomenclature of Paper/Cource	Creditc	Contact Hours/week	Internal Marks	External	Total	Duration of	
Core Course	BCL-306AD	Chemistry-III	A			Marks	Marks	exam (Hrs)	
		(Periodic Properties & States of Matter)		4	30	10	100	3	
Core Course	BCP-304AD	Chemistry Lab-III	2	4	30	70	100	4	
Total			6	8	60	140	200		

SEMESTER-IV											
Type of Course	Course Code	Nomenclature of Paper/Course	Credits	Contact Hours/week	Internal Marks	External Marks	Total Mark s	Duration of exam (Hrs)			
Core Course	BCL-406AD	Chemistr-IV (Basics of Organic Chemistry & Analytical Techniques)	4	4	30	70	100	3			
Core Course	BCP-404AD	Chemistry Lab-IV	2	4	30	70	100	4			
Total			6	8	60	140	200				

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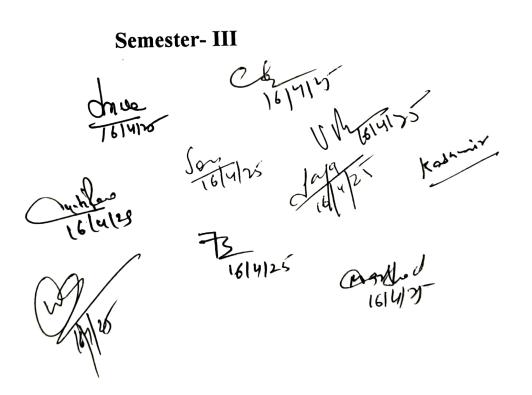
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Proposed Scheme and Syllabus for Additional Subjects for Eligibility as Trained Graduate Teacher (TGT) for the students of Dual degree B.Sc. (Hons) -M.Sc. Programme in Physics/ Mathematics (w.e.f. Session 2025-26).

Subject: Chemistry

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# CHEMISTRY-III (Periodic Properties & States of Matter)

Paper code: BCL-306AD 60 Hrs (4Hrs/week) Credits: 4 Time for Major Examination: 3Hrs

*Note:* The examiner is requested to set nine questions in all, selecting two questions from each UNIT and one compulsory question (Question No.1 based on entire syllabus that will consist of seven short answer type questions each of two marks). The candidate is required to attempt five questions in all selecting one from each UNIT and the compulsory Question No.1.

#### **UNIT-I**

## **Periodicity of Elements**

s, p, d, f block elements, the long form of periodic table. Detailed discussion of the following properties of the elements, with reference to s and p-block.

(a) Effective nuclear charge, shielding or screening effect, Slater rules, variation of effective nuclear charge in periodic table.

(b) Atomic radii (van der Waals)

(c) Ionic and crystal radii.

(d) Covalent radii (octahedral and tetrahedral)

(e) Ionization enthalpy, Successive ionization enthalpies and factors affecting ionization energy. Applications of ionization enthalpy.

(f) Electron gain enthalpy, trends of electron gain enthalpy.

(g) Electronegativity, Pauling's/ Mulliken's/ Allred Rachow's/ and Mulliken-Jaffe's electronegativity scales. Variation of electronegativity with bond order, partial charge, hybridization, group electronegativity. Sanderson's electron density ratio.

#### UNIT-II

#### Chemistry of s and p Block Elements

Inert pair effect, Relative stability of different oxidation states, diagonal relationship and anomalous behaviour of first member of each group. Allotropy and catenation. Complex formation tendency of s and p block elements.

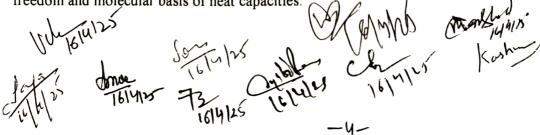
Hydrides and their classification ionic, covalent and interstitial. Basic beryllium acetate and nitrate.

#### UNIT-III

#### **Gaseous state**

Kinetic molecular model of a gas: derivation of the kinetic gas equation; collision frequency and diameter; mean free path and viscosity of gases, temperature and pressure dependence, relation between mean free path and coefficient of viscosity.

Maxwell distribution and its use in evaluating molecular velocities (average, root mean square and most probable) and average kinetic energy, law of equipartition of energy, degrees of freedom and molecular basis of heat capacities.  $\bigcirc$ 



# Marks for Major Test (External): 70 Marks for Internal Exam: 30 Total Marks: 100

15 Hrs

#### 15 Hrs

## 15 Hrs

Behaviour of real gases: Deviations from ideal gas behaviour, compressibility factor, and its variation with pressure. Van der Waals equation of state, its derivation and application in explaining real gas behaviour, mention of other equations of state (Berthelot, Dietrici); virial equation of state; Van Der Waals equation expressed in virial form and calculation of Boyle temperature. Isotherms of real gases and their comparison with Van Der Waals isotherms, continuity of states, critical state.

#### **UNIT-IV**

## Solid state

## 15 Hrs

Nature of the solid state, law of constancy of interfacial angles, law of rational indices, Miller indices, elementary ideas of symmetry, symmetry elements and symmetry operations, qualitative idea of point and space groups, seven crystal systems and fourteen Bravais lattices; X-ray diffraction, Bragg's law, a simple account of rotating crystal method and powder pattern method. Analysis of powder diffraction patterns of NaCl, CsCl and KCl. Defects in crystals. Glasses and liquid crystals.

#### **BOOKS SUGGESTED:**

- 1. Lee, J.D. Concise Inorganic Chemistry ELBS, 1991.
- 2. Douglas, B.E. and McDaniel, D.H. Concepts & Models of Inorganic Chemistry Oxford, 1970.
- 3. Day, M.C. and Selbin, J. Theoretical Inorganic Chemistry, ACS Publications, 1962.
- 4. Rodger, G.E. Inorganic and Solid State Chemistry, Cengage Learning India Edition, 2002
- 5. Atkins, P. W. & Paula, J. de Atkin's Physical Chemistry 10th Ed., Oxford University Press (2014).
- 6. Ball, D. W. Physical Chemistry Thomson Press, India (2007).
- 7. Castellan, G. W. Physical Chemistry 4th Ed. Narosa (2004).
- 8. Mortimer, R. G. Physical Chemistry 3rd Ed. Elsevier: NOIDA, UP (2009).
- 9. Engel, T. & Reid, P. Physical Chemistry 3rd Ed. Pearson (2013).

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## CHEMISTRY LAB-III

Paper code: BCP-304AD 60 Hrs (4Hrs/week) Credits: 2 Time for Major Examination: 4Hrs

Marks for Major Test (External): 70 Marks for Internal Exam: 30 Total Marks: 100

## (A) Inorganic preparations

(i) Cuprous Chloride [Cu<sub>2</sub>Cl<sub>2</sub>]

(ii) Aluminium potassium sulphate (Potash alum) [KAl(SO<sub>4</sub>)<sub>2</sub>.12H<sub>2</sub>O]

## (B) Acid-Base Titrations

(i) Estimation of carbonate and hydroxide present together in mixture.

(ii) Estimation of carbonate and bicarbonate present together in a mixture.

(iii) Estimation of free alkali present in different soaps/detergents.

# (C) Phase equilibria

(i) Construction of the phase diagram using cooling curves or ignition tube method:

a. simple eutectic and

b. congruently melting systems.

(ii) Distribution of acetic/ benzoic acid between water and cyclohexane.

# (D). pHmetry

(i) Study the effect on pH of addition of HCl/NaOH to solutions of acetic acid, sodium acetate and their mixtures.

(ii) Preparation of buffer solutions of different pH

a. Sodium acetate-acetic acid

b. Ammonium chloride-ammonium hydroxide

(iii) pH metric titration of (i) strong acid vs. strong base, (ii) weak acid vs. strong base.

# **BOOKS SUGGESTED:**

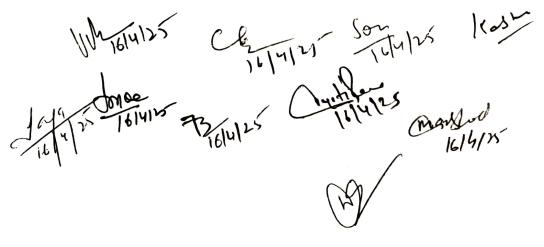
1. Mendham, J., A. I. Vogel's Quantitative Chemical Analysis 6th Ed., Pearson, 2009.

2. Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011).

3. Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. Experiments in Physical Chemistry 8th Ed.; McGraw-Hill: New York (2003).

4. Halpern, A. M. & McBane, G. C. Experimental Physical Chemistry 3rd Ed.; W.H. Freeman & Co.: New York (2003).

5. Yadav J. B. Advanced Practical Physical Chemistry.



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Semester- IV

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# **CHEMISTRY-IV**

# (Basics of Organic Chemistry & Analytical Techniques)

Paper code: BCL-406AD 60 Hrs (4Hrs/week) Credits: 4 Time for Major Examination: 3Hrs

# Marks for Major Test (External): 70 Marks for Internal Exam: 30 **Total Marks: 100**

*Note:* The examiner is requested to set nine questions in all, selecting two questions from each UNIT and one compulsory question (Question No.1 based on entire syllabus that will consist of seven short answer type questions each of two marks). The candidate is required to attempt five questions in all selecting one from each UNIT and the compulsory Question No.1.

## **UNIT-I**

## **Basics of Organic Chemistry**

Classification, and Nomenclature, Hybridization, Shapes of molecules, Influence of hybridization on bond properties of Organic Compounds.

Dipole moment; Organic acids and bases; their relative strength, Curly arrow rules, formal charges; Nucleophlicity and basicity.

Introduction to types of organic reactions and their mechanism: Addition, Elimination and Substitution reactions.

#### Aromatic Hydrocarbons

Aromaticity: Huckel's rule, aromatic character of arenes, Electrophilic aromatic substitution: halogenation, nitration, sulphonation and Friedel-Craft's alkylation/acylation with their mechanism. Directing effects of the groups.

#### **UNIT-I**

## **Chemistry of Aliphatic Hydrocarbons**

## **Carbon-Carbon** sigma bonds

Chemistry of alkanes: Formation of alkanes, Wurtz Reaction, Wurtz-Fittig Reactions, Free radical substitutions: Halogenation -relative reactivity and selectivity.

# Carbon-Carbon pi bonds

Formation of alkenes and alkynes by elimination reactions, Mechanism of E1, E2, E1cb reactions. Saytzeff and Hofmann eliminations.

Reactions of alkenes: Electrophilic additions their mechanisms (Markownikoff/ Anti Markownikoff addition), mechanism of oxymercuration-demercuration, hydroborationoxidation, ozonolysis, reduction (catalytic and chemical), syn and anti-hydroxylation (oxidation). 1,2-and 1,4-addition reactions in conjugated dienes and, Diels-Alder reaction; Reactions of alkynes: Acidity, Electrophilic and Nucleophilic additions. Hydration to form carbonyl compounds, Alkylation of terminal alkynes.

#### UNIT-III

#### Spectroscopy

UV-Visible Spectrometry: Basic principles of instrumentation (choice of monochromator and detector) for single and double beam instrument.

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5 Hrs

9 Hrs

6 Hrs

#### 10 Hrs

## 15 Hrs

*Infrared Spectrometry:* Basic principles of instrumentation (choice of source, monochromator & detector) for single and double beam instrument; sampling techniques. Structural illustration through interpretation of data, Effect and importance of isotope substitution.

Flame Atomic Absorption and Emission Spectrometry: Basic principles of instrumentation (choice of source, monochromator, detector, choice of flame and Burner designs. Techniques of atomization and sample introduction; Method of background correction, sources of chemical interferences and their method of removal. Techniques for the quantitative estimation of trace level of metal ions from water samples.

### UNIT-III

## Thermal methods of analysis

Basic principles and instrumentation of TG, DTA and DSC. Quantitative estimation of Ca and Mg from their mixture.

# **Electroanalytical** methods

Classification of electroanalytical methods, basic principles of pH metric, potentiometric and conductometric titrations. Techniques used for the determination of equivalence points and pKa values.

## **Books Suggested:**

1. Morrison, R. N., Boyd, R. N. & Bhattacharjee S. K. Organic Chemistry, 7thed. Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).

2. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).

3. McMurry, J.E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning India Edition, 2013.

4. Mendham, J., A. I. Vogel's Quantitative Chemical Analysis 6th Ed., Pearson, 2009.

5. Willard, H.H. et al.: Instrumental Methods of Analysis, 7th Ed. Wardsworth Publishing Company, Belmont, California, USA, 1988.

6. Christian, G.D. Analytical Chemistry, 6th Ed. John Wiley & Sons, New York, 2004.

7. Harris, D.C. Exploring Chemical Analysis, 9th Ed. New York, W.H. Freeman, 2016.

8. Khopkar, S.M. Basic Concepts of Analytical Chemistry. New Age International Publisher, 2009.

9. Skoog, D.A. Holler F.J. & Nieman, T.A. Principles of Instrumental Analysis, Cengage Learning India Ed.

10. Mikes, O. Laboratory Hand Book of Chromatographic & Allied Methods, Elles Harwood Series on Analytical Chemistry, John Wiley & Sons, 1979.

11. Ditts, R.V. Analytical Chemistry; Methods of separation, van Nostrand, 1974.

Tolus Kasting

# 7 Hrs

8 Hrs

#### **CHEMISTRY LAB-IV**

# Paper code: BCP-404AD 60 Hrs (4Hrs/week) Credits: 2 Time for Major Examination: 4Hrs

## Marks for Major Test (External): 70 **Marks for Internal Exam: 30 Total Marks: 100**

#### 1. Chromatography

a. Separation of a mixture of two amino acids by ascending and horizontal paper chromatography.

b. Separation of a mixture of two sugars by ascending paper chromatography.

c. Separation of a mixture of o-and p-nitrophenol or o-and p-aminophenol by thin layer chromatography (TLC).

2. Functional group tests for alcohols, phenols, carbonyl, carboxylic acid nitro, amine and amide groups.

# 3. Organic Preparations

a. Dibenzalacetone

b. *m*-dinitrobenzene.

#### **BOOKS SUGGESTED:**

1.Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009).

2. Furniss, B.S., Hannaford, A.J., Smith, P.W.G. & Tatchell, A.R. Practical OrganicChemistry, 5th Ed. Pearson (2012)

3. Ahluwalia, V.K. & Dhingra, S. Comprehensive Practical Organic Chemistry: Qualitative Analysis, University Press (2000).

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