

# Syllabus for Ph.D Degree 2023-2024

## Ph.D. in Analytical Chemistry

### Separation Techniques for Ph.D. in Analytical Chemistry

#### Introduction

Important total analysis process steps: Sampling, Methods, Separation , Quantitation , Evaluation

#### Separation Science

-Definition of Separation Science

-Classification and Application of Separations

I- Separation by Phase-Formation methods

- Volatilization Methods (conversion of Solid to Gas)
- Distillation Methods (conversion of Liquid to Gas)
- Separation by Precipitation

II- Separation by Phase- transformation methods

#### Extraction

Solvent extraction (Liquid Extraction)

1.1. The equilibrium constant

1.2. Efficiency of extraction

1.3. Selectivity of extraction

1.3.1. Nature of partition forces (Dispersion interaction, Dipole-Dipole interaction, Induction interaction, Hydrogen bonding)

1.4. Extraction system

1.5.1. Extraction of Covalent, Neutral Molecules (pH effect, Effect of complex formation, Effect of association, Methods of Extraction , Batch extraction, Continuous extraction, Multistage extraction)

Solid-Phase Extraction (Liquid-Solid Extraction), Principle and Technique

Cloud point of extraction

Microextraction (Dispersive liquid-Liquid Microextraction, Single drops microextraction)

#### Chromatographic Methods

1- Introduction and some important definition in Chromatography

2- Chromatographic Methods

2.1. Plate theory

2.2. Rate theory

3- Chromatographic resolution

4- Classifications of chromatographic Methods

5- Adsorption Chromatography

6- Partition Chromatography

7- Plane Chromatography

7.1. Paper Chromatography (PC)

7.1.1. Techniques of Paper Chromatography

7.1.2. Preparative paper chromatography

7.1.3. Qualitative and Quantitative application of PC

8- Thin Layer Chromatography (TLC)

9- Liquid Chromatography (LC)

10- High performance Liquid Chromatography (HPLC)

10.1. Bonded-Phase Column

- 10.2. Elution System
- 11- Ion-Pair Chromatography
- 12- Ion Exchange Chromatography (IEC)
- 13- Size Exclusion Chromatography
- 14- Gas-Chromatography (GC)

## **Instrumental Analysis for Ph.D. in Analytical Chemistry**

### **Molecular Spectroscopy**

- Molecular Absorption Spectroscopy
- Molecular Emission Spectroscopy
- Turbidimetry and Nephelometry

### **Atomic Spectroscopy**

- Atomic Emission Spectroscopy
- Atomic Absorption Spectroscopy

### **Automated methods of analysis**

### **Electrochemical techniques for analysis**

Potentiometry

Voltametry

Construction of electrodes using nanoparticles)

## **Biochemistry / for Ph.D. in Analytical Chemistry**

### **Carbohydrates**

- Importance of carbohydrates
- Classes of Carbohydrates and their examples
- Glycolysis and Pentose phosphate pathway

### **Lipids**

- Importance of Lipids
- Classes of lipids
- Omega fatty acids
- Cholesterol and Phospholipids

### **Protein**

- Amino acids
- Classification of amino acids
- Protein structure
- Classification of protein according to their functions
- Classification of enzyme
- Mechanism of enzyme's action
- Factors affecting the activity of enzyme

### **Metabolism**

- Digestion of carbohydrates in the body
- Glycolysis and Pentose phosphate pathway
- Metabolism of galactose
- Digestion of lipids in the body
- $\beta$ -oxidation
- Biosynthesis of fatty acids

## Organic Chemistry / for Ph.D. in Analytical Chemistry

### Aryl Halides

- Reactions:
- EAS Electrophilic Aromatic Substitution with mechanism
- NAS Nucleophilic Aromatic substitution with mechanism

### Carbonyl condensation reaction with mechanism

- Aldol condensation
- Dehydration of Aldol products (synthesis of Enones)
- Important of Aldol condensation
- Crossed Aldol condensation
- The Claisen Ester Condensation
- Crossed Claisen condensation
- Rearrangement and Neighboring group Effects.
- Hoffmann rearrangement (migration to electron deficient Nitrogen)

### Organic structure Determination

- Instrumental Methods of Structure determination

### Infrared spectroscopy

## Physical Chemistry / for Ph.D. in Analytical Chemistry

- Introduction in Kinetic theory:
- Classification of Kinetic molecular gas.
- Pressure of Ideal gas in kinetic theory.
- Internal energy of an ideal gas.
- Zero and first law, second law, Third law
- Thermodynamic description of mixtures
- Phase diagram
- Chemical equilibrium
  
- Expression of rates. Stoichiometric relationships of rates of different substances in a reaction
- Determination of reaction orders, rate laws, and rate constant by method of initial rate
- Determination of rate laws by graphical or integration method
- Determination of half-lives
- Determination of activation energy
- Elementary steps and reaction mechanism
- Effect of catalysts

**Organic Chemistry / for Ph.D. in Organic Chemistry**

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**<sup>1</sup>H, <sup>13</sup>C-NMR**

**Mass spectroscopy**

**Natural Products / for Ph.D. in Organic Chemistry**

**Terpenes and Essential oils**

- Introduction
- Classification
- Structures of monoterpenes

**Chemistry of Flavonoids**

- Definition
- Classification
- Glycoside flavonoids

**Alkaloid Compounds**

- Definition and types
- Opioids, Potential Binding Groups
- Opioids, Structure activity relationships

**Analytical Chemistry / for Ph.D. in Organic Chemistry**

**Fundamentals of Analytical Chemistry:**

- Methods for the expression of concentration
- Chemical Stoichiometry

**Separations Techniques:**

- Extraction
- Chromatographic Theories
- Chromatographic Resolutions

- Adsorption Chromatography
- Ion Exchange Chromatography
- Paper Chromatography
- Thin-layer Chromatography
- Liquid Chromatography
- High performance Liquid Chromatography
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**Physical Chemistry / for Ph.D. in Physical Chemistry**

- Properties of matter and physical/chemical equilibria
- Chemical equilibrium
- Determination of equilibrium constant
- Thermodynamic equilibrium constant
- $K_p$  and  $K_c$  for gaseous reaction
- Le Châtelier's Principle
- Properties of equilibrium constant
- The Phosgene equilibrium
- Effect of inert gases on equilibrium
- The equilibrium constant for heterogeneous reaction
- Effect of pressure on heterogeneous equilibria
- Variation of  $K_a$  &  $K_p$  with Temperature.
- Physical equilibria involving pure substance
- Clausius-Clapeyron equation
- Trouton's Rule
- Criteria of equilibria
- Physical Properties of Matter
- Evidence of Chemical Change
- Gibbs free energy
- Properties of Gibbs free energy

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