School of Chemistry
Faculty of Sciences
University of the Punjab, Lahore
Course Outline

Semester-VIII

Programme	**BS Chemistry**	**Course Code**	**Chem-408**	**Credit Hours**	**2**
Course Title	**Polymer Chemistry**		**Course Type**	**Major (Elective)**	

Course Introduction

This course introduces the fundamentals of polymer science, including polymer classification, polymerization kinetics, and the synthesis of copolymers. Students will explore the mechanisms of condensation and addition polymerizations, such as free radical, cationic, and anionic processes, and study methods for determining molecular mass averages and molecular mass distributions. The course also covers analysis techniques for polymers, including spectroscopic methods (UV-visible and IR) and thermal analysis.
Here is a brief description of course outlines:
An introduction to polymers, Classification of polymers, kinetics of condensation and addition (free radical, cationic and anionic polymerization), copolymers and their classification, kinetics of copolymerization, concept of molecular mass average in polymers and its determination Molecular mass distribution, determination of molecular mass average (viscosity average, number average and weight average) by different methods. Analysis techniques like spectroscopic methods (UV visible and IR) and thermal analysis.

Learning Outcomes

On the completion of the course, the students will be able to:

1. classify polymers, understand and apply polymerization kinetics for condensation and addition processes, and analyze copolymerization mechanisms.
2. They will be proficient in determining molecular mass averages and distributions using various methods, and utilize spectroscopic (UV-visible and IR) and thermal analysis techniques for polymer characterization

Course Content		**Assignments/Readings**
Week 1	An introduction to polymers	
	Continued	
Week 2	Classification of polymers,	
	Continued	
Week 3	Continued	
	kinetics of condensation and addition (free radical, cationic and anionic polymerization)	
Week 4	Continued	
	Continued	
Week 5	Continued	
	copolymers and their classification	

Week 6	kinetics of copolymerization,	
	concept of molecular mass average in polymers and its determination	
Week 7	Continued	
	Continued	
Week 8	**Mid Term Examinations**	
Week 9	Molecular mass distribution	
	Continued	
Week 10	determination of molecular mass average (viscosity average, number average and weight average) by different methods	
	Continued	
Week 11	Continued	
	Continued	
Week 12	Continued	
	Continued	
Week 13	Continued	
	Continued	
Week 14	Analysis techniques like spectroscopic methods (UV visible and IR) and thermal analysis.	
	Continued	
Week 15	Continued	
	Continued	
Week 16	**Final Term Examinations**	

Textbooks and Reading Material

1. Billmeyer, F., Textbook of Polymer Science, 2nd ed., John Wiley and Sons, Inc., NY, 1971.
2. Bhatti, H. N. & Farooqi, Z. H., Modern Physical Chemistry, Revised ed., Caravan Book House, Lahore, 2014.
3. Alberty, R.A., and Silbey. R.J., Physical Chemistry, John Wiley, New York, 1995.
4. Atkins, P.W. Physical chemistry, 5th Ed., W. H. Freeman and Company, New York, 1994.
5. Kundu, N., Jain, S.K., Physical Chemistry, S. Chand and Co., New Dehli, 1984.

Teaching Learning Strategies

1. Lectures
2. Group Discussion
3. Laboratory work
4. Seminar/ Workshop

Assignments: Types and Number with Calendar
1. Numerical problem sets relevant to topic will be given as assignments from week 1 to week 16. **2.** Literature review based assignment relevant to the course will also be given during the course.

Assessment

Sr. No.	Elements	Weightage	Details
1.	Midterm Assessment	35%	Written Assessment at the mid-point of the semester.
2.	Formative Assessment	25%	Continuous assessment includes: Classroom participation, assignments, presentations, viva voce, attitude and behavior, hands-on-activities, short tests, projects, practical, reflections, readings, quizzes etc.
3.	Final Assessment	40%	Written Examination at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

Semester-VIII					
Programme	**BS Chemistry**	**Course Code**	**Chem-409**	**Credit Hour**	**1**
Course Title	**Physical Chemistry Lab-I**		**Course Type**	**Major (Elective)**	

Course Introduction

This course offers practical experience in polymer characterization and solution thermodynamics, including molecular mass determination of polymers through viscosity measurements, heat of solution determination, and critical micelle concentration (CMC) analysis of block copolymers. Students will also prepare various polymeric systems, characterize them using FTIR, and determine partial molar properties to gain insights into their behavior and interactions. Here is a brief description of course outlines:
Molecular Mass Determination of different Polymers by Viscosity measurement.
Determination of heat of solution of a substance by solubility methods.
Determination of CMC of block copolymer/polymeric surfactant by surface tension method.
Preparation of different polymeric systems and their characterization by FTIR.
Determination of partial molar properties.

Learning Outcomes

On the completion of the course, the students will be able to:

1. determine the molecular mass of different polymers using viscosity measurements, assess the heat of solution for substances, and analyze the critical micelle concentration (CMC) of block copolymers through surface tension methods.
2. They will also be skilled in preparing and characterizing polymeric systems with FTIR and calculating partial molar properties

	Course Content	Assignments/Readings
Week 1	Molecular Mass Determination of different Polymers by Viscosity measurement.	
	Continued	
Week 2	Continued	
	Continued	
Week 3	Continued	
	Determination of heat of solution of a substance by solubility methods.	
Week 4	Continued	
	Continued	
Week 5	Continued	
	Continued	
Week 6	Determination of CMC of block copolymer/polymeric surfactants by surface tension method.	
	Continued	
Week 7	Continued	

	Continued	
Week 8	**Mid Term Examinations**	
Week 9	Preparation of different polymeric systems and their characterization by FTIR.	
	Continued	
Week 10	Continued	
	Continued	
Week 11	Continued	
	Continued	
Week 12	Continued	
	Determination of partial molar properties.	
Week 13	Continued	
	Continued	
Week 14	Continued	
	Continued	
Week 15	Continued	
	Continued	
Week 16	**Final Term Examinations**	

Textbooks and Reading Material

1. Garland, C. W., Nibler, J. W., Shoemaker, D. P., Experiments in Physical Chemistry, 6th ed., WCB McGraw-Hill, 1996.
2. Singh, A., Advanced Experimental Physical Chemistry, Campus Books International, 2007.
3. Daniels F., Experimental Physical Chemistry, 7th ed., McGraw-Hill College, 1970.
4. Matthews, G. P., Experimental Physical Chemistry, Oxford University Press, 1986.
5. Bhatti, H. N. & Farooqi, Z. H., Experimental Physical Chemistry for Graduate and Postgraduate Students, Revised ed., Caravan Book House, Lahore, 2014.

Teaching Learning Strategies

1. Lectures
2. Group Discussion
3. Laboratory work
4. Seminar/ Workshop

Assignments: Types and Number with Calendar

1. Lab activities and performance relevant to topic will be given as assignments from week 1 to week 16.
2. Literature review based assignment relevant to the course will also be given during the course.

Assessment			
Sr. No.	**Elements**	**Weightage**	**Details**
4.	Midterm Assessment	35%	Written Assessment at the mid-point of the semester.
5.	Formative Assessment	25%	Continuous assessment includes: Classroom participation, assignments, presentations, viva voce, attitude and behavior, hands-on-activities, short tests, projects, practical, reflections, readings, quizzes etc.
6.	Final Assessment	40%	Written Examination at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

Semester-VIII					
Programme	**BS Chemistry**	**Course Code**	**Chem-410**	**Credit Hours**	**2**
Course Title	**Photochemistry**		**Course Type**	**Major (Elective)**	

Course Introduction

This course covers fundamental principles and applications of photochemistry, including basic laws, quantum efficiency, and photophysical processes. Students will learn about the Jablonski diagram, fluorescence, phosphorescence, quenching, and the Stern-Volmer equation. The course also examines photochemical reaction kinetics, vision photochemistry, photosensitized reactions, chemiluminescence, and the working and applications of lasers. Practical applications such as photopolymers, photocatalytic reactions, photodynamic therapy, and perovskite solar cells are also explored.

Here is a brief description of course outlines:

Basic Laws of photochemistry, quantum efficiency and its determination, Jablonski's diagram, photophysical processes (radiative and non-radiative), quantitative aspects of fluorescence and phosphorescence, concept of delayed fluorescence, quantitative aspects of fluorescence and phosphorescence quenching, Stern-Volmer equation, kinetics and mechanism of photochemical reactions Photochemistry of vision, photosensitized reactions, chemiluminescence. LASERS (working and applications). Application of Photochemistry: including Photopolymers, Photocatalytic Reactions (Water splitting and degradation of pollutants), Photodynamic Therapy and Photo Chemotherapy, Perovskite solar cells, and different versatile applications.

Learning Outcomes

On the completion of the course, the students will be able to:

1. Understand and apply the basic laws of photochemistry and quantum efficiency.
2. Analyze photophysical processes using the Jablonski diagram.
3. Quantitatively assess fluorescence, phosphorescence, and their quenching, utilizing the Stern-Volmer equation.
4. Explore the kinetics and mechanisms of photochemical reactions.
5. Explain the photochemistry of vision, photosensitized reactions, and chemiluminescence.
6. Describe the working principles and applications of lasers.
7. Apply photochemistry in practical contexts, such as photopolymers, photocatalytic reactions, photodynamic therapy, and perovskite solar cells.

	Course Content	Assignments/Readings
Week 1	Basic Laws of photochemistry	
	Continued	
Week 2	Quantum efficiency and its determination	
	Jablonski's diagram	
Week 3	Photophysical processes (radiative and non-radiative)	
	Continued	
Week 4	quantitative aspects of fluorescence	
	quantitative aspects of phosphorescence	

Week 5	concept of delayed fluorescence	
	quantitative aspects of fluorescence and phosphorescence quenching	
Week 6	quantitative aspects of fluorescence and phosphorescence quenching	
	Stern-Volmer equation	
Week 7	kinetics and mechanism of photochemical reactions (photochemical formation of HBr and photochemical decomposition of acetaldehyde)	
	Continued	
Week 8	**Mid Term Examinations**	
Week 9	photochemistry of vision	
	photosensitized reactions	
Week 10	chemiluminescence	
	LASERS (working and applications)	
Week 11	LASERS (working and applications)	
	Application of Photochemistry	
Week 12	Photopolymers	
	Photocatalytic Reactions (Water splitting and degradation of pollutants)	
Week 13	Continued	
	Photodynamic Therapy	
Week 14	Photo Chemotherapy	
	Perovskite solar cells, and different versatile applications.	
Week 15	Continued	
	Continued	
Week 16	**Final Term Examinations**	

Textbooks and Reading Material

1. Suppan, P., Chemistry and Light, Royal Society of Chemistry, London, 1994.
2. Turro, N. J., Modern Molecular Photochemistry, University Science Books, Sausalito, CA, 1991.
3. Mukherjee, K.K.R., Fundamentals of Photochemistry, Revised Ed., New Age International (P) limited, Publishers, New Delhi, 2000.
4. Kundu, N., and Jain, S.K.S. Physical Chemistry, S. Chand and Co., New Dehli, 1984.
5. Atkins, P.W., Physical chemistry, 5th Ed., W. H. Freeman and Company, New York, 1994.
6. Alberty, R.A. and Silbey. R.J., Physical Chemistry, John Wiley, New York, 1995.
7. Bhatti, H. N. and Farooqi, Z. H., Modern Physical Chemistry, Revised ed., Caravan Book House, Lahore, 2014.

Teaching Learning Strategies

1. Lectures
2. Group Discussion
3. Laboratory work
4. Seminar/ Workshop

Assignments: Types and Number with Calendar

1. Numerical problem sets relevant to topic will be given as assignments from week 1 to week 16.
2. Literature review based assignment relevant to the course will also be given during the course.

Assessment

Sr. No.	Elements	Weightage	Details
1.	Midterm Assessment	35%	Written Assessment at the mid-point of the semester.
2.	Formative Assessment	25%	Continuous assessment includes: Classroom participation, assignments, presentations, viva voce, attitude and behavior, hands-on-activities, short tests, projects, practical, reflections, readings, quizzes etc.
3.	Final Assessment	40%	Written Examination at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

Semester-VIII					
Programme	**BS Chemistry**	**Course Code**	**Chem-411**	**Credit Hour**	**1**
Course Title	**Physical Chemistry Lab-2**		**Course Type**	**Major (Elective)**	

Course Introduction

This course provides hands-on experience with a variety of spectroscopic techniques for characterizing compounds and analyzing their properties. Students will learn to use FTIR spectroscopy for compound characterization, evaluate pKa values of indicators spectrometrically, and determine the percentage of copper in samples using spectroscopy. The course also includes UV-Vis spectroscopy for compound characterization, calculating molar extinction coefficients of colored substances, and determining the wavelength of maximum absorption. Additionally, students will learn to measure specific and molar rotation of optically active substances and predict normal modes of vibration for simple molecules to interpret their IR spectra.

Here is a brief description of course outlines:

Predicting normal modes of vibration for simple molecules and interpretation of their IR Spectra.

Determination of specific rotation and molar rotation of optically active substances (sucrose and glucose).

Determination of wavelength of maximum absorption of various colored substances.

Determination of molar extinction co-efficient of a colored substance.

Characterization of the given compound by UV-Vis spectroscopy.

Spectroscopic determination of Cu percentage in the given sample.

Evaluate the pKa values of indicators using spectrometric methods.

Characterize compounds using FTIR spectroscopy.

Learning Outcomes

On the completion of the course, the students will:

1. Use FTIR and UV-Vis spectroscopy for compound characterization.
2. Evaluate pKa values using spectrometric methods.
3. Determine copper percentage in samples.
4. Calculate molar extinction coefficients.
5. Measure specific rotation of optically active substances.
6. Interpret IR spectra of simple molecules.

	Course Content	**Assignments/Readings**
Week 1	Predicting normal modes of vibration for simple molecules and interpretation of their IR Spectra.	
	Continued	
Week 2	Continued	
	Determination of specific rotation and molar rotation of optically active substances (sucrose and glucose).	
Week 3	Continued	
	Continued	
Week 4	Continued	

	Determination of wavelength of maximum absorption of various colored substances.	
Week 5	Continued	
	Continued	
Week 6	Continued	
	Determination of molar extinction co-efficient of a colored substance	
Week 7	Continued	
	Continued	
Week 8	**Mid Term Examinations**	
Week 9	Characterization of the given compound by UV-Vis spectroscopy.	
	Continued	
Week 10	Continued	
	Continued	
Week 11	Spectroscopic determination of Cu percentage in the given sample.	
	Continued	
Week 12	Continued	
	Evaluate the pKa values of indicators using spectrometric methods.	
Week 13	Continued	
	Continued	
Week 14	Characterize compounds using FTIR spectroscopy.	
	Continued	
Week 15	Continued	
	Continued	
Week 16	**Final Term Examinations**	

Textbooks and Reading Material

1. Garland, C. W., Nibler, J. W., Shoemaker, D. P., Experiments in Physical Chemistry, 6th ed., WCB McGraw-Hill,1996.
2. Singh, A., Advanced Experimental Physical Chemistry, Campus Books International, 2007.
3. Daniels F., Experimental Physical Chemistry, 7th ed., McGraw-Hill College, 1970.
4. Matthews, G. P., Experimental Physical Chemistry, Oxford University Press, 1986.
5. Bhatti, H. N. & Farooqi, Z. H., Experimental Physical Chemistry for Graduate and Postgraduate Students, Revised ed., Caravan Book House, Lahore, 2014.

Teaching Learning Strategies
1. Lectures 2. Group Discussion 3. Laboratory work 4. Seminar/ Workshop

Assignments: Types and Number with Calendar
1. Lab activities and performance relevant to topic will be given as assignments from week 1 to week 16. **2.** Literature review based assignment relevant to the course will also be given during the course.

Assessment

Sr. No.	Elements	Weightage	Details
4.	Midterm Assessment	35%	Written Assessment at the mid-point of the semester.
5.	Formative Assessment	25%	Continuous assessment includes: Classroom participation, assignments, presentations, viva voce, attitude and behavior, hands-on-activities, short tests, projects, practical, reflections, readings, quizzes etc.
6.	Final Assessment	40%	Written Examination at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

Semester-VIII					
Programme	**BS Chemistry**	**Course Code**	**Chem-412**	**Credit Hours**	**2**
Course Title	**Spectroscopy**		**Course Type**	**Major (Elective)**	

Course Introduction

This course covers key areas of molecular spectroscopy, including rotational and vibrational spectroscopy, and electronic and Raman spectroscopy. Students will explore the rotational energies of diatomic and polyatomic molecules, determine bond lengths using rotational spectra, and understand vibrational energies and modes. The course also delves into the interpretation of IR spectra, Fermi resonance, and various applications and sampling techniques. Additionally, it examines electronic transitions, the fine structure of atomic spectra, and the principles and theories of Raman spectroscopy, focusing on rotational and vibrational Raman spectra of molecules.

Here is a brief description of course outlines:

Rotational Spectroscopy and Vibrational Spectroscopy

Special regions of molecular spectroscopy; Rotational energies of diatomic molecules and polyatomic molecules, Determination of bond length by rotational spectra.

Vibrational energy of harmonic oscillator, types of vibrational modes. Vibrational of polyatomic molecules, interpretation of IR spectra of simple molecules, Fermi resonance, applications and sampling techniques.

Electronic and Raman Spectroscopy

Principles of electronic transitions. Types of electronic transitions. Energies of atomic orbital-with reference of H-atom spectrum electronic angular momentum fine structure of H-atom spectrum.

Raman Spectra-idea of Raman scattering, Theories of Raman spectroscopy. Rotational Raman Spectra of linear Molecules. Pure Rotational-Vibrational Raman spectra of molecules.

Learning Outcomes

On the completion of the course, the students will:

1. acquire a specialized understanding of how light interacts with molecules and materials.
2. Different methods of optical spectroscopy and their use to examine chemical and physical properties.

	Course Content	**Assignments/Readings**
Week 1	Unit-I Rotational Spectroscopy and Vibrational Spectroscopy Special regions and classification of spectroscopy	
	Rotational energies of diatomic molecules	
Week 2	Rotational energies of polyatomic molecules	
	Determination of bond length by rotational spectra.	
Week 3	Continued	
	Vibrational energy of harmonic oscillator.	
Week 4	types of vibrational modes.	
	Vibrational of polyatomic molecules	
Week 5	Continued	

	interpretation of IR spectra of simple molecules	
Week 6	Continued	
	Fermi resonance	
Week 7	applications	
	sampling techniques.	
Week 8	**Mid Term Examinations**	
Week 9	Unit II- Electronic and Raman Spectroscopy	
	Principles of electronic transitions	
Week 10	Types of electronic transitions	
	Energies of atomic orbital-with reference of H-atom spectrum electronic angular momentum fine structure of H-atom spectrum.	
Week 11	Continued	
	Continued	
Week 12	Raman Spectra-idea of Raman scattering	
	Theories of Raman spectroscopy.	
Week 13	Continued	
	Rotational Raman Spectra of linear Molecules	
Week 14	Continued	
	Pure Rotational-Vibrational Raman spectra of molecules.	
Week 15	Continued	
	Continued	
Week 16	**Final Term Examination**	

Textbooks and Reading Material

1. Barrow, G. M., Molecular Spectroscopy, McGraw-Hill, New York, 1962.
2. Barrow, G. M., The Structure of Molecules, W. A. Benjamin, New York, 1963.
3. Alberty, R. A. and Silbey, R. J. Physical Chemistry, 3rd ed., John Wiley & Sons, Inc., New York, 2001.
4. Atkins, P. W., Physical Chemistry, 7th ed., W. H. Freeman and Company, New York, 2002.
5. Chang, R., Physical Chemistry the Chemical and Biological Sciences, 3rd ed., University Science Books, Sausalito, CA, 2000.
6. Laidler, K. J., Meiser, J. H., and Sanctuary, B. C., Physical Chemistry, 4th ed., Houghton Mifflin Company, Boston, 2002.
7. Levine, I. N., Physical Chemistry, 5th ed., McGraw-Hill, Inc., New York, 2002.
8. Winn, J. S., Physical Chemistry, Harper Collins College Publishers, New York, 1995.
9. Noggle, J. H., Physical Chemistry, Harper Collins College Publishers, New York, 1996.

Teaching Learning Strategies
1. Lectures 2. Group Discussion 3. Laboratory work 4. Seminar/ Workshop

Assignments: Types and Number with Calendar
1. Numerical problem sets relevant to topic will be given as assignments from week 1 to week 16. 2. Literature review based assignment relevant to the course will also be given during the course.

Assessment

Sr. No.	Elements	Weightage	Details
1.	Midterm Assessment	35%	Written Assessment at the mid-point of the semester.
2.	Formative Assessment	25%	Continuous assessment includes: Classroom participation, assignments, presentations, viva voce, attitude and behavior, hands-on-activities, short tests, projects, practical, reflections, readings, quizzes etc.
3.	Final Assessment	40%	Written Examination at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

Semester-VIII					
Programme	**BS Chemistry**	**Course Code**	**Chem-413**	**Credit Hour**	**1**
Course Title	**Spectroscopy Lab**		**Course Type**	**Major (Elective)**	

Course Introduction

This course provides hands-on experience in various analytical techniques. Students will determine the kinetics of blue dye with hypochlorite bleach, quantify the mass of acetylsalicylic acid in aspirin, and measure the copper content in brass using a spectrometer. The course also includes investigating photosynthesis with algae beads, analyzing the percentage composition of two colored components in solution, and interpreting IR and Raman spectra of simple molecules.
Here is a brief description of course outlines:
Determination of Kinetics of Blue Dye with Hypochlorite Bleach.
Determine the mass of acetylsalicylic acid (ASA) in a single aspirin tablet.
Determination of percentage composition of Copper in Brass by Spectrometer
Investigating Photosynthesis with Algae Beads.
Determination of percentage composition of two coloured components in solution.
Interpretation of IR Spectra and Raman spectra of simple molecules.

Learning Outcomes

On the completion of the course, the students will be able to:

1. Determine the kinetics of blue dye with hypochlorite bleach.
2. Quantify the mass of acetylsalicylic acid in an aspirin tablet.
3. Measure the percentage composition of copper in brass using spectrometry.
4. Investigate photosynthesis using algae beads.
5. Analyze the percentage composition of two colored components in a solution.
6. Interpret IR and Raman spectra of simple molecules.

	Course Content	Assignments/Readings
Week 1	Determination of Kinetics of Blue Dye with Hypochlorite Bleach.	
	Continued	
Week 2	Continued	
	Continued	
Week 3	Continued	
	Determine the mass of acetylsalicylic acid (ASA) in a single aspirin tablet.	
Week 4	Continued	
	Continued	
Week 5	Continued	
	Continued	
Week 6	Determination of percentage composition of Copper in Brass by Spectrometer	
	Continued	

Week 7	Continued	
	Continued	
Week 8	**Mid Term Examinations**	
Week 9	Investigating Photosynthesis with Algae Beads.	
	Continued	
Week 10	Continued	
	Continued	
Week 11	Continued	
	Determination of percentage composition of two coloured components in solution.	
Week 12	Continued	
	Continued	
Week 13	Continued	
	Interpretation of IR Spectra and Raman spectra of simple molecules	
Week 14	Continued	
	Continued	
Week 15	Continued	
	Continued	
Week 16	**Final Term Examination**	

Textbooks and Reading Material

1. Garland, C. W., Nibler, J. W., Shoemaker, D. P., Experiments in Physical Chemistry, 6th ed., WCB McGraw-Hill,1996.
2. Singh, A., Advanced Experimental Physical Chemistry, Campus Books International, 2007.
3. Daniels F., Experimental Physical Chemistry, 7th ed., McGraw-Hill College, 1970.
4. Matthews, G. P., Experimental Physical Chemistry, Oxford University Press, 1986.
5. Bhatti, H. N. & Farooqi, Z. H., Experimental Physical Chemistry for Graduate and Postgraduate Students, Revised ed., Caravan Book House, Lahore, 2014.

Teaching Learning Strategies

1. Lectures
2. Group Discussion
3. Laboratory work
4. Seminar/ Workshop

Assignments: Types and Number with Calendar
1. Lab activities and performance relevant to topic will be given as assignments from week 1 to week 16. **2.** Literature review based assignment relevant to the course will also be given during the course.

Assessment			
Sr. No.	**Elements**	**Weightage**	**Details**
4.	Midterm Assessment	35%	Written Assessment at the mid-point of the semester.
5.	Formative Assessment	25%	Continuous assessment includes: Classroom participation, assignments, presentations, viva voce, attitude and behavior, hands-on-activities, short tests, projects, practical, reflections, readings, quizzes etc.
6.	Final Assessment	40%	Written Examination at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

Semester-VIII					
Programme	**BS Chemistry**	**Course Code**	**Chem-414**	**Credit Hours**	**3**
Course Title	**Nuclear Chemistry**		**Course Type**	**Major (Elective)**	

Course Introduction

This course explores the composition, properties, and stability of atomic nuclei, covering natural
and artificial radioactivity, rate laws of radioactive disintegration, and nuclear transformations. Students will study accelerators, nuclear fission and fusion, and their applications, as well as radiation hazards, safety measures, and detection methods. The course also includes the use of tracers in chemistry and radioactive dating techniques.
Here is a brief description of course outlines:
Composition and properties of the nucleus, stability of nucleus, nucleus models, natural and artificial radioactivity, rate law of radioactive disintegration, determination of half life and average life of radioactive elements, successive radioactive decay and radioactive equilibrium, transformation of elements, accelerators (cyclotron and linear accelerators), nuclear processes; nuclear fission, atomic bomb, nuclear reactor, nuclear fusion, hydrogen bomb, steller energy, radiation hazards and safety measures, detection and measurements of nuclear radiations, use of tracers in chemistry, radioactive dating.

Learning Outcomes

On the completion of the course, the students will:

1. understand the properties and stability of atomic nuclei, natural and artificial radioactivity, and the principles of nuclear transformations.
2. They will also learn to detect and measure nuclear radiation, identify radiation hazards, implement safety measures, and apply techniques such as the use of tracers in chemistry and radioactive dating.

	Course Content	**Assignments/Readings**
Week 1	Composition and properties of the nucleus	
	stability of nucleus	
Week 2	nucleus models	
	Continued	
Week 3	natural and artificial radioactivity	
	rate law of radioactive disintegration	
Week 4	determination of half life and average life of radioactive elements	
	Continued	
Week 5	successive radioactive decay	
	radioactive equilibrium,	
Week 6	transformation of elements	
	Continued	
Week 7	accelerators (cyclotron and linear accelerators)	

	Continued	
Week 8	**Mid Term Examinations**	
Week 9	nuclear processes;	
	nuclear fission	
Week 10	atomic bomb	
	nuclear reactor	
Week 11	nuclear fusion	
	hydrogen bomb	
Week 12	steller energy	
	radiation hazards and safety measures	
Week 13	Continued	
	detection and measurements of nuclear radiations,	
Week 14	use of tracers in chemistry	
	Continued	
Week 15	radioactive dating	
	continued	
Week 16	**Final Term Examinations**	

Textbooks and Reading Material

1. Kundu, N., and Jain, S.K.S. Physical Chemistry, Chand and Company Ltd. 1984.
2. Bhatti, H. N., and Farooqi, Z. H., Modern Physical Chemistry, Revised ed., Caravan Book House, Lahore, 2014.
3. Bahl A., Bahl B.S. & Tuli G.D., Essential of Physical Chemistry, S. Chand Publishing New Dehli, 2000.
4. Maron S.H. and Prutton C.F., Principles of Physical Chemistry, Macmillan and Co. Ltd. 1965.
5. Atkins, P.W., Physical Chemistry 5th Ed., W.H. Freeman and Company, New York, 1994.
6. Barrow G.M., Physical Chemistry, McGraw Hill, Tokyo, 1973

Teaching Learning Strategies

1. Lectures
2. Group Discussion
3. Laboratory work
4. Seminar/ Workshop

Assignments: Types and Number with Calendar

1. Numerical problem sets relevant to topic will be given as assignments from week 1 to week 16.
2. Literature review based assignment relevant to the course will also be given during the course.

Assessment			
Sr. No.	**Elements**	**Weightage**	**Details**
1.	Midterm Assessment	35%	Written Assessment at the mid-point of the semester.
2.	Formative Assessment	25%	Continuous assessment includes: Classroom participation, assignments, presentations, viva voce, attitude and behavior, hands-on-activities, short tests, projects, practical, reflections, readings, quizzes etc.
3.	Final Assessment	40%	Written Examination at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.