SARDAR PATEL UNIVERSITY
Vallabh Vidyanagar, Gujarat
(Reaccredited with 'A' Grade by NAAC (CGPA 3.25)
Syllabus with effect from the Academic Year 2022-2023

PROGRAMME STRUCTURE
Master of Science in Chemistry
MSc (Physical Chemistry) Semester: III

Programme Outcome (PO) - For MSc Chemistry Programme	Master of Science program provides extended theoretical and practical knowledge of different science subjects. Master of Science programme at Sardar Patel University is designed keeping the overall back ground preparation in mind for the student to either seek a job or to become an entrepreneur. The students, after completion of Bachelor of Science can select the master's programme in the subject they have had at the final year or in a related discipline (depending upon eligibility criteria prescribed by university). **Programme outcomes: At the end of the program, the students will be able to** 1. Have a deep understanding of both the theoretical and practical concepts in the respective subject. 2. Understand laboratory processes and use scientific equipments and work independently. 3. Develop research temperament as a consequence of their theory and practical learning. 4. Communicate scientific information in oral and written form. 5. Understand the issues related to nature and environmental contexts and think rationally for sustainable development. 6. The students are able to handle unexpected situations by critically analyzing the problem.
Programme Specific Outcome (PSO) - For MSc Chemistry Semester - III	Students will have a firm foundation in the fundamentals and application of current chemical and scientific theories including those in Analytical Inorganic Chemistry, Organic Chemistry, Physical Chemistry, Chemistry and Industrial polymer Chemistry. After completing M.Sc. chemistry program, students will be able to: ■ Demonstrate and apply the fundamental knowledge of the basic principles in various fields of Chemistry. ■ Apply knowledge to build up small scale industry for developing endogenous product. ■ Collaborate effectively on team-oriented projects in the field of chemistry or other related fields. ■ Communicate scientific information in a clear and concise manner both orally and in writing. ■ Inculcate logical thinking to address a problem and become result oriented with a positive attitude. ■ Enhance the scientific temperament among the students so as to develop a research culture and implementation of the policies to tackle the burning issues at global and local level.

	■ Apply the knowledge to develop the sustainable and eco-friendly technology. ■ Take up global level research opportunities to pursue Ph.D programme targeted approach and specific competitive exams conducted by service commission ■ Accept enormous job opportunities at all level of chemical industries, pharmaceutical industries and placements in R & D.

To Pass	At least 40% Marks in the University Examination in each paper and 40% Marks in the aggregate of University and Internal examination in each course of Theory, Practical & 40% Marks in Viva-voce.

Course Type	**Course Code**	**Name of Course**	**Type of Course**	**T /P**	**Credit**	Hours per Week	**Exam Duration in hrs**	**Component of Marks**		
								Internal	**External**	**Total**
								Total/ Passing	**Total/ Passing**	**Total/ Passing**
Core Course	PS03CPHC51	Spectroscopy and Molecular Structure	EM & EN	T	4	4	3	30/10	70/28	100/40
	PS03CPHC52	Electro-analytical Methods	EM	T	4	4	3	30/10	70/28	100/40
	PS03CPHC53	Selected Topics in Physical Chemistry – I	EM& EN	T	4	4	3	30/10	70/28	100/40
Core Course (Any One)	PS03CPHC54	Practicals **OR**	EM&SD	P	4	8	6	30/10	70/28	100/40
	PS03CPHC55	Project Work	EM&SD	P	4	8		30/10	70/28	100/40
Core Course (Any One)	PS03CPHC56	Practicals **OR**	EM&SD	P	4	8	6	30/10	70/28	100/40
	PS03CPHC57	Project Work	EM&SD	P	4	8		30/10	70/28	100/40
Core Course	PS03CPHC58	Comprehensive Viva		-	1	1			50/20	50/20
Elective Course (Any one)	PS03ECHE51	Separation methods	EM& EN	T	4	4	3	30/10	70/28	100/40
	PS03ECHE52	Analytical techniques in Materials characterization	EM& EN	T	4	4	3	30/10	70/28	100/40
	PS03ECHE53	Applications of Inorganic Chemistry in Industry	EM& EN	T	4	4	3	30/10	70/28	100/40
	PS03ECHE54	Selected Topics in Advanced Inorganic Chemistry-I	EM& EN	T	4	4	3	30/10	70/28	100/40

	PS03ECHE55	Mechanical and Electrical Properties of Polymers	EM& EN	T	4	4	3	30/10	70/28	100/40
	PS03ECHE56	Selected Topics in Polymers-I	EM& EN	T	4	4	3	30/10	70/28	100/40
	PS03ECHE57	Advanced Characterization Techniques	EM& EN	T	4	4	3	30/10	70/28	100/40
	PS03ECHE58	Selected Topics in Physical Chemistry-II	EM& EN	T	4	4	3	30/10	70/28	100/40
	PS03ECHE59	Selected Topics in Organic Chemistry	EM& EN	T	4	4	3	30/10	70/28	100/40
	PS03ECHE60	Occupational Practices	EM& EN	T	4	4	3	30/10	70/28	100/40
					25					650
Add-on Course		MOOCs course from Swayam Portal								

EMPLOYABILITY = EM, ENTREPRENEURSHIP = EN and SKILL DEVELOPMENT = SD

* Project work **(as optional) in place of practicals; to be offered to some of the students, based on their merit, interest and placement with the teachers (Marks : 200). The project shall have to be carried out under the allotted teacher(s) and a dissertation shall be submitted and will be assessed for internal (60 marks) and external (140 marks), in the usual manner.**

Master in Science, Physical Chemistry
M. Sc. Physical Chemistry, Semester – III

Course Code	**PS03CPHC51**	Title of the Course	Spectroscopy and Molecular Structure
Total Credits of the Course	**04**	Hours per Week	**04**

Course Objectives:	The student will acquire basic knowledge of the interaction of radiation with matter and will be able to use various molecular spectroscopic techniques for structure determination. From this study, different functional groups as well as plausible structure can be determined.

Course Content

Unit	**Description**	**Weightage* (%)**
I	Interaction of radiation with matter, semi-classical treatment, time dependent perturbation theory and transition rates. **UV-spectroscopy :** Theory and principles of electronic transition, chromophores and auxochromes, Woodward-Fieser rules, Effect of conjugation, Characteristic absorptions in organic compounds. **Infra-red spectroscopy :** Principle, Theory of Molecular Vibrations, Rotation and vibration of diatomic molecules : frequency, force constant, energy and selection rules based on spectroscopy and symmetry. Vibrations of polyatomic molecules, classical and quantum mechanical approach, Local and normal modes of analysis and structure with suitable examples, Applications	25
II	**Raman Spectroscopy :** Raman effect, theory of Raman spectra, Characteristics of Raman lines, Raman spectra of diatomic molecules, selection rules, instrumentation, applications. **Microwave spectroscopy :** Introduction, Differences between Microwave spectroscopy and IR Spectroscopy, Theory of Microwave Spectroscopy, Diatomic molecules as a Rigid rotator, Selection Rules for Rotational Spectra, Instrument for Microwave spectroscopy, Applications.	25
III	**^{1}H-Nuclear Magnetic Resonance :** Origin of Chemical shift and spin-spin coupling, Fourier Transform technique, Pulse sequence, relaxation processes, Use of integration in the quantative determination of isomers, Factors affecting chemical shifts (inductive, resonance and anisotropic effect with examples), chemical shift of different types of protons (alkane, alkene, alkyne and allene etc.), different spin systems (AB, AM, AX, AB2, AX2, A2B2, A2X2,….). Factors affecting coupling constants (dihedral angle, Karplus equation-graph, electronegativity, bond order, hybridization, bond angle with examples). Double resonance, spin-spin decoupling, Nuclear Overhauser effect with examples.	25
IV	**Mass spectroscopy :** Theory, instrumentation, method of ionization (field ionization, FAB, MALDI, californium plasma), different detectors [magnetic analyser, ion cyclotron analyser, quandruple mass filter], time of flight	25

	(TOF). Importance of HRMS, Rules of fragmentation of different functional groups, factors controlling fragmentation examples such as drugs, ionic liquids etc.	

Teaching-Learning Methodology	Chalk and board method along with ICT tools Model demonstration as per the demand of the topic

Evaluation Pattern		
Sr. No.	**Details of the Evaluation**	**Weightage**
1.	Internal Written / Practical Examination (As per CBCS R.6.8.3)	15%
2.	Internal Continuous Assessment in the form of Practical, Viva-voce, Quizzes, Seminars, Assignments, Attendance (As per CBCS R.6.8.3)	15%
3.	University Examination	70%

Course Outcomes: Having completed this course, the learner will be able to	
1.	To learn the basic Principle, instrumentation, theory, application and problems of molecular spectroscopy (UV-vis, IR, Raman, Microwave etc).
2.	To identify the various functional groups from the UV-vis as well IR spectroscopy by determining maximum absorption as well as vibrational frequencies.
3.	To gain insight in proton and carbon environment in the organic molecules using Nuclear magnetic resonance (NMR) spectroscopy.
4.	To realize the various fragment of molecules through mass spectroscopic techniques that helps to study the molecular structure.

Suggested References:	
Sr. No.	**References**
1.	Introduction to Spectroscopy, Donald L. Pavia, Gary M. Lampman, George S. Kriz, 3rd Edition, Thomson Brooks/Cole publisher.
2.	Physical Chemistry, Ira N. Levine, 4th Edition, Tata-McGraw Hill Edition
3.	Spectroscopy, Donald L. Pavia, Gary M. Lampman, George S. Kriz, James R. Vyvyan, 1st Indian Edition, Brooks/Cole Cengage Learning, 4th Edition

4.	Molecular Spectroscopy : Theory and Applications, Raman Patel & Raman Patel, University Press, 1st Edition
5.	Atomic and Molecular Spectroscopy: Basic concepts and Applications. Rita Kakkal, Cambridge Publication, 1st Edition
6.	Molecular Spectroscopy, I. N. Levine, Wiley-Interscience Publication
7.	Atomic and Molecular Spectroscopy, Mool Chand Gupta, New Age International Publisher
8.	Modern Spectroscopy, J. M. Hollas, John Wiley & Sons
9.	High Resolution Spectroscopy, J. M. Hollas, Butterworths
10.	Fundamentals of Molecular Spectroscopy, C. N. Banwell and E. M. McCash, Tata McGraw Hill publishing
11.	Physical Chemistry: A Molecular Approach, Donald A. McQuarrie, John D. Simon, Viva Books, Viva Student Edition, Reprint Edn

On-line resources to be used if available as reference material
On-line Resources
www.nptel.ac.in
www.swayam.gov.in
www.epgp.inflibnet.ac.in (e-PG pathshala)
www.ndl.iitkgp.ac.in (National Digital Library)

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Master in Science, Physical Chemistry
M. Sc. Physical Chemistry, Semester – III

Course Code	**PS03CPHC52**	Title of the Course	**Electro-analytical Methods**
Total Credits of the Course	**04**	Hours per Week	**04**

Course Objectives:	The course is design to apply the measurements based on electrochemical properties as tools for qualitative and quantitative analysis of simple to complex systems. The basic theory, principle, instrumental methods and application parts are very useful in the analysis of industrial products for quality control and assurance.

Course Content

Unit	Description	Weightage* (%)
I	**pH metry & its applications :** Introduction, Construction and working of different electrodes, Ion selective electrodes, applications of pHmeasurements, Acid-base titrations, Polybasic acid-base titrations, Determination of dissociation constant of weak acids and weak bases, Determination of hydrolysis constant and degree of hydrolysis	25
II	**Potentiometry :** Introduction, Principle, Types of electrodes and its classifications, Chemical cell with and without transference, concentration cell with and without transference, EMF and thermodynamics of cell reactions, Measurements of single electrodes, Determination of activity coefficient from EMF measurements, Potentiometric titration methods, oxidation – reduction titration, argentometric titration, applications	25
III	**Conductometry and High Frequency Conductometry :** Introduction, Definition of basic terms and their interrelationship, factors affecting conductance, types of cell, conductometric titrations, Applications – different types of acid-base titrations, complex formation titration, Determination of degree of dissociation, dissociation constant, basicity of organic acids, solubility and solubility product of sparingly soluble salts, degree of hydrolysis and hydrolysis constant, Advantages of conductometry titration. **High Frequency Conductometry :** Introduction, Types of cells, Instrumentation, Importance of relationship between conventional conductance measurement and capacitance, advantages and disadvantages, applications.	25
IV	**Voltammetric Techniques :** Introduction, Principle, Instrument, Electrode system, advantages and disadvantages, components of limiting currents, polarography – polarography maxima, half-wave potential, Determination of relationship between half wave potential & diffusion coefficient, Factors governing diffusion current, calibration curve method. Voltammetric methods and its applications, **Amperometry** – Principle, Apparatus, Different types of amperometric titration, advantages and disadvantages, applications.	25

Teaching-Learning Methodology	Chalk and board method along with ICT tools Model demonstration as per the demand of the topic

Evaluation Pattern		
Sr. No.	**Details of the Evaluation**	**Weightage**
1.	Internal Written / Practical Examination (As per CBCS R.6.8.3)	15%
2.	Internal Continuous Assessment in the form of Practical, Viva-voce, Quizzes, Seminars, Assignments, Attendance (As per CBCS R.6.8.3)	15%
3.	University Examination	70%

Course Outcomes: Having completed this course, the learner will be able to	
1.	Student will understand the detailed measurements of electrochemical properties, the instrumentation, measuring tools and aids such as electrode system, their construction and development.
2.	The methods of analysis under direct as well as alternate currents streams are taught.
3.	Complex systems based on real samples can be handled for qualitative and quantitative determination of chemical species in pure aqueous solutions and also in complex samples which also have other interfering species.

Suggested References:

Sr. No.	**References**
1.	Principles of Instrumental Analysis, Douglas A. Skoog, F. James Hooer, Timothy A. Nieman.
2.	Instrumental Methods of Analysis, Willard, Merritt, Dean, Settle, CBS Publishers & Distributors
3.	Contemporary Chemical Analysis, J. F. Rubinson and K. A. Rubinson, Princtice-Hall International Inc..
4.	Introduction to Instrumental Analysis, Robert D. Braun, McGraw-Hill Book company, New Delhi.
5.	The Principles of Electrochemistry, Duncan A. Maclnnes, Dover Publications Inc., N.Y

6.	Instrumental Methods of Chemical Analysis, B. K. Sharma, Goel Publishing House, Meerut.
7.	Instrumental methods of Chemical Analysis, V. K. Ahluwalia, Ane Books Pvt. Ltd.

On-line resources to be used if available as reference material
On-line Resources
www.nptel.ac.in
www.swayam.gov.in
www.epgp.inflibnet.ac.in (e-PG pathshala)
www.ndl.iitkgp.ac.in (National Digital Library)

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Master in Science, Physical Chemistry
M. Sc. Physical Chemistry, Semester – III

Course Code	**PS03CPHC53**	Title of the Course	**Selected Topics in Physical Chemistry – I**
Total Credits of the Course	**04**	Hours per Week	**04**

Course Objectives:	The course aims to introduce the students to the concepts of statistical Thermodynamics and electrochemistry and their industrial applications. The statistical treatment is a tool for understanding concepts used in other subjects related to Solid State Physics, Pharmaceutical sci., Optical, Electrical and Magnetic Properties, Semiconductors, Magnetic Materials, Superconducting, Materials, Phase Diagrams, Physical Metallurgy etc. Electrochemistry is useful to provide inside knowledge of advanced devices like sensors, solar cells, fuel cells, batteries etc.

Course Content

Unit	Description	Weightage* (%)
I	**Statistical Thermodynamics - I :** Introduction, Frequency distribution, Binomial, Poisson and normal distribution, Energy states and energy levels, macro states and microstates, thermodynamics probability, the Bose – Einstein statistics, the Fermi – Dirac statistics, the Maxwell – Bolzmann statistics	25
II	**Statistical Thermodynamics – II :** The statistical interpretation of entropy, the Bose – Einstein distribution function, The Fermi-Dirac distribution function, the classical distribution, comparison of distribution functions for indistinguishable particles, the Maxwell – Boltzmann distribution function, the partition function, thermodynamics properties of system	25
III	**Electrochemistry – I :** Introduction, Electrolysis, Arrhenius theory of ionization, Ostwald's dilution law, Application of electrolysis, Ionic atmosphere its radius, Relaxation time, DHO equation and its validity and limitation Wein effect, DH effect, Industrial applications of Electrochemistry : Batteries, Fuel cells, Solar cells.	25
IV	**Electrochemistry – II :** Kinetics of Electrode reactions : Essentials of electrode reactions, Butler-Volmmer model for electrode kinetics, one step, one electron process through potential energy diagram, standard rate constants and transfer coefficients, equilibrium condition and exchange current, current-over potential equation. Marcus microscopic model, predictions from Marcus theory, Gerischer model based on distribution of energy states, Tunnelling and extended charge transfer	25

Teaching-Learning Methodology	Chalk and board method along with ICT tools Model demonstration as per the demand of the topic

Evaluation Pattern		
Sr. No.	**Details of the Evaluation**	**Weightage**
1.	Internal Written / Practical Examination (As per CBCS R.6.8.3)	15%
2.	Internal Continuous Assessment in the form of Practical, Viva-voce, Quizzes, Seminars, Assignments, Attendance (As per CBCS R.6.8.3)	15%
3.	University Examination	70%

Course Outcomes: Having completed this course, the learner will be able to	
1.	To understand the concept of probability and its use for understanding of Statistical thermodynamics. The distributions like Binomial, Poisson, Normal are applicable to different types of data.
2.	To get information on various types of statistical approaches and understand its application in the determination of various partition function in the form entropy.
3.	To get inside into the distribution of particles in various energy levels and evaluation of various thermodynamic parameters in terms of partition function.

Suggested References:	
Sr. No.	**References**
1.	Molecular Statistics for Students of Chemistry, L. A. Woodward Clarendon Press, Oxford
2.	Elements of Statistics for Students of Chemistry, L. K. Nash, Wesley Publishing Co., London.
3.	Thermodynamics, Kinetic Theory and Statistical Thermodynamics, Francis W. Sears, Gerhard L. Salinger, Narosa Publishing House, New Delhi.
4.	Industrial Electrochemistry, Derek Pletche, Chapmann & Hall, New York.
5.	Modern Electrochemistry, Vol. 1 &2., J. M. Bockrisand A. K. N. Reddy, Plenum Press, New York.
6.	Electrochemical Methods, A. J. Bard and L. R. Faulkner, John Wiley & Sons, 2nd Edition

7.	The Principles of Electrochemistry, Duncan A. MacInnes, Dover Publications Inc., New York.
8.	Electrolytic Solutions, R. A. Robinson and R. H. Stokes, Butterworths, London.

On-line resources to be used if available as reference material
On-line Resources
www.nptel.ac.in
www.swayam.gov.in
www.epgp.inflibnet.ac.in (e-PG pathshala)
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Master in Science, Physical Chemistry
M. Sc. Physical Chemistry, Semester – III

Course Code	**PS03CPHC54**	Title of the Course	**Practicals - Instrumental methods**
Total Credits of the Course	**04**	Hours per Week	**08**

Course Objectives:	The Physical Chemistry laboratory experiments illustrating some instrumental methods based exercises dealing with quantative measurements of chemical substances in general.

Course Content	
1.	To carry out the following conductometric titrations at room temperature. (a) Solution of a strong acid (hydrochloric acid) with a solution of strong alkali (sodium hydroxide). (b) Solution of a weak acid (acetic acid) with a solution of strong alkali (sodium hydroxide). (c) Solution of a strong acid (hydrochloric acid) with a solution of weak alkali (ammonium hydroxide).
2.	To determine the stability constant of co-ordination compound (copper-5-sulfosalicyclic acid) by pH-metry.
3.	To titrate pH metrically a phosphoric acid solution against alkali and calculate the first, second and third neutralization or ionization constants of the acid.
4.	To study the rate equation for the mutarotation of D-glucose in water.
5.	To study the variation of refractive index with composition of mixtures of carbon tetrachloride and ethyl acetate.
6.	To find out the amount of Borax in given solution by titrating it against hydrochloric acid pH metrically.
7.	To determine the standard redox potential and thermodynamics parameters of the Fe^{2+} ion by potentiometry technique.
8.	To determine the concentrations of KI by potentiometry.
9.	To determine the amounts of aspirin content in a given tablet by conductometry.
10.	To determine the amount of Paracetamol in a given tablet by spectrophotometer.
11.	To determine the concentrations of Fe(III) solutions by spectrophotometric titrations with EDTA.
12.	To study the effect of electrolytes on water structure by Viscosity/conductometry.
	Other practicals related to instruments like spectrophotometer, conductometer, potentiometer, refractometer, pH-meter, polarimeter etc. can also be given.

Teaching-Learning Methodology	Practical demonstration with the explanation of theory/mechanism involved in the experiment

Evaluation Pattern		
Sr. No.	**Details of the Evaluation**	**Weightage**
1.	Internal Written / Practical Examination (As per CBCS R.6.8.3)	30%
2.	University Examination	70%

Course Outcomes: Having completed this course, the learner will be able to	
1.	Know the various instrumental based methods for determination of dissociation constant, concentration of an unknown materials, std. electrode potential, rate constant etc. by performing various type of titrations and instruments.

Suggested References:	
Sr. No.	**References**
1.	Experiments in Physical Chemistry, J. M. Wilson, R. J. Newcombe, A. R. Denaro, R. M. W. Rickett, Pergamon Press, Oxford.
2.	Findlay's Practical Physical Chemistry, B. P. Levitt, Longman Group Limited, 9th Edition.
3.	A Laboratory Manual of Experiments in Physical Chemistry, D. Brennan, C. F. H. Tipper, McGraw-Hill Publishing Company Ltd., London.
4.	Advanced Physico-Chemical Experiments : A Textbook of Practical Physical Chemistry and Calculations. J. Rose, Sir Isaac Pitman & Sons Ltd., London.
5.	Experimental Physical Chemistry, R. C. Das, B. Behera, Tata McGraw-Hill Publishing Company Ltd., New Delhi.
6.	Advanced Physical Chemistry Experiments, J. N. Gurtu, A. Gurtu, Pragati Prakashan, Meerut, 5th Ed., 2011.

On-line resources to be used if available as reference material
On-line Resources (for theory/mechanism involve in the experiments)
www.nptel.ac.in
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www.ndl.iitkgp.ac.in (National Digital Library)

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Master in Science, Physical Chemistry
M. Sc. Physical Chemistry, Semester – III

Course Code	**PS03CPHC55**	Title of the Course	**Project Work**
Total Credits of the Course	**04**	Hours per Week	**08**

Course Objectives:	To provide exposure to research problem and carry out research in the novel and fascinating topics of research in chemistry.

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Master in Science, Physical Chemistry
M. Sc. Physical Chemistry, Semester – III

Course Code	**PS03CPHC56**	Title of the Course	**Practicals – Physico-chemical Exercises**
Total Credits of the Course	**04**	Hours per Week	**08**

Course Objectives:	The Physical Chemistry laboratory experiments dealing with the interrelation between the composition and properties of matter such as autocatalysis reaction, distribution method, hydrolysis method, solubility product, partial molal volume.

Course Content	
1.	To investigate the autocatalysis reaction between Potassium permanganate and Oxalic acid.
2.	To determine the distribution coefficient of benzoic acid between benzene and water.
3.	To determine the formula of the complex ion formed between the curperic ion and ammonia (cupramonium ion) by distribution method.
4.	To determine the rate constant of the oxidation of Iodide ion by hydrogen peroxide in aqueous solutions.
5.	To determine the relative strength of HCl and H_2SO_4 by studying the hydrolysis of methyl acetate.
6.	To study the variation in the solubility of calcium hydroxide in the presence of sodium hydroxide and determine the solubility product of calcium hydroxide at room temperature.
7.	To study the phase diagram of the ternary system, HAc, H_2O and $CHCl_3$.
8.	To determine the molar volume and partial molal volume of given liquid at 25 ^oC.
9.	Kinetics of the reaction of ferric and iodide ions – use of initial rates.
10.	To study oscillations chemical reaction (Briggs-Raucher reactions).
11.	To investigate the adsorption isotherm of oxalic acid or acetic acid from aqueous solutions by activated charcoal and examine the validity of classical and Langmuir's adsorptions isotherm.
12.	To determine Cl^- ion concentration in a given sample of water.
	Depending on availability of time, some experiments may be added/exchange during the semester.

Teaching-Learning Methodology	Practical demonstration with the explanation of theory/mechanism involved in the experiment

Evaluation Pattern		
Sr. No.	**Details of the Evaluation**	**Weightage**
1.	Internal Written / Practical Examination (As per CBCS R.6.8.3)	30%
2.	University Examination	70%

Course Outcomes: Having completed this course, the learner will be able to	
1.	To investigate the autocatalysis reaction, to determine the distribution coefficient, the formula of the complex ion formed between metal and ligand, determination of the rate constant, relative strength, the solubility product. To study the phase diagram of the ternary system, determine the molar volume and partial molal volume of given liquid.

Suggested References:	
Sr. No.	**References**
1.	Experiments in Physical Chemistry, J. M. Wilson, R. J. Newcombe, A. R. Denaro, R. M. W. Rickett, Pergamon Press, Oxford.
2.	Findlay's Practical Physical Chemistry, B. P. Levitt, Longman Group Limited, 9th Edition.
3.	A Laboratory Manual of Experiments in Physical Chemistry, D. Brennan, C. F. H. Tipper, McGraw-Hill Publishing Company Ltd., London.
4.	Advanced Physico-Chemical Experiments : A Textbook of Practical Physical Chemistry and Calculations. J. Rose, Sir Isaac Pitman & Sons Ltd., London.
5.	Experimental Physical Chemistry, R. C. Das, B. Behera, Tata McGraw-Hill Publishing Company Ltd., New Delhi.
6.	Advanced Physical Chemistry Experiments, J. N. Gurtu, A. Gurtu, Pragati Prakashan, Meerut, 5th Ed., 2011.

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Master in Science, Physical Chemistry
M. Sc. Physical Chemistry, Semester – III

Course Code	**PS03CPHC57**	Title of the Course	**Project Work**
Total Credits of the Course	**04**	Hours per Week	**08**

Course Objectives:	To provide exposure to research problem and carry out research in the novel and fascinating topics of research in chemistry.

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Master in Science, Physical Chemistry
M. Sc. Physical Chemistry, Semester – III

Course Code	**PS03CPHC58**	Title of the Course	**Comprehensive Viva**
Total Credits of the Course	**01**	Hours per Week	**02**

Course Objectives:	To assess the overall knowledge of the student in the relevant subjects covered in core as well as elective courses.

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