CURRICULUM AND SYLLABUS FOR INTEGRATED MSC IN CHEMISTRY

NATIONAL INSTITUTE OF TECHNOLOGY DURGAPUR
CURRICULUM
OF
INTEGRATED MSC IN CHEMISTRY

2023 ONWARD UNDERGRADUATE ADMISSION BATCH

V0:

First Year Curriculum Recommended by members of UGAC	19.08.2023
First Year Curriculum Approved by the Chairman, Senate	19.08.2023
First Year Curriculum & Syllabus ratified in the 71st Senate meeting (Item No. 71.5(b))	18.12.2023
Entire Curriculum and Syllabus Recommended by UGAC	09.12.2024
Entire Curriculum and Syllabus Approved by the 73rd Senate (Item No. 73.8)	23.03.2025

CURRICULUM AND SYLLABUS FOR INTEGRATED MSC IN CHEMISTRY

DEPARTMENT OF CHEMISTRY
Program Name: Integrated M.Sc. in CHEMISTRY
DETAILED CURRICULUM
CURRICULUM OF 2023 ONWARD UNDERGRADUATE ADMISSION BATCH FOR Integrated M.Sc. in CHEMISTRY
L= Lecture hour/ week; T= Tutorial hour/ week; S= Sessional/ practical hour/ week
C= Subject credit point; H= Subject contact hour/ week.

GROUP – 1

FIRST SEMESTER

Semester - I							
Sl. No.	**Code**	**Subject**	**L**	**T**	**S**	**C**	**H**
1	MAC01	Mathematics - I	3	1	0	4	4
2	CSC01	Computer Programming	2	1	0	3	3
3	XEC01	Engineering Mechanics	2	1	0	3	3
4	XEC02	Basic Electrical and Electronics Engineering	3	0	0	3	3
5	ESC01	Ecology and Environment	2	0	0	2	2
6	CYC01	Engineering Chemistry	3	0	0	3	3
7	CSS51	Computer Programming Laboratory	0	0	3	2	3
8	XES52	Basic Electrical and Electronics Engineering Laboratory	0	0	3	2	3
9	CYS51	Engineering Chemistry Laboratory	0	0	2	1	2
		TOTAL	**15**	**3**	**8**	**23**	**26**

SECOND SEMESTER

Semester - II							
Sl. No.	**Code**	**Subject**	**L**	**T**	**S**	**C**	**H**
1	MAC02	Mathematics - II	3	1	0	4	4
2	CSC02	Data Structure and Algorithms	2	1	0	3	3
3	PHC01	Engineering Physics	2	1	0	3	3
4	HSC01	Professional Communication	2	0	2	3	4
5	CSS52	Data Structure and Algorithms Laboratory	0	0	3	2	3
6	XES51	Engineering Graphics	0	1	3	3	4
7	PHS51	Engineering Physics Laboratory	0	0	2	1	2
8	XXS51	Extra Academic Activities	0	0	2	1	2
		TOTAL	**9**	**4**	**12**	**20**	**25**

CURRICULUM AND SYLLABUS FOR INTEGRATED MSC IN CHEMISTRY

GROUP – 2

FIRST SEMESTER

Semester - I							
Sl. No.	**Code**	**Subject**	**L**	**T**	**S**	**C**	**H**
1	MAC01	Mathematics - I	3	1	0	4	4
2	CSC01	Computer Programming	2	1	0	3	3
3	XEC01	Engineering Mechanics	2	1	0	3	3
4	PHC01	Engineering Physics	2	1	0	3	3
5	HSC01	Professional Communication	2	0	2	3	4
6	CSS51	Computer Programming Laboratory	0	0	3	2	3
7	XES51	Engineering Graphics	0	1	3	3	4
8	PHS51	Engineering Physics Laboratory	0	0	2	1	2
9	XXS51	Extra Academic Activities	0	0	2	1	2
		TOTAL	**11**	**5**	**12**	**23**	**28**

SECOND SEMESTER

Semester - II							
Sl. No.	**Code**	**Subject**	**L**	**T**	**S**	**C**	**H**
1	MAC02	Mathematics - II	3	1	0	4	4
2	CSC02	Data Structure and Algorithms	2	1	0	3	3
3	XEC02	Basic Electrical and Electronics Engineering	3	0	0	3	3
4	ESC01	Ecology and Environment	2	0	0	2	2
5	CYC01	Engineering Chemistry	3	0	0	3	3
6	CYS51	Engineering Chemistry Laboratory	0	0	2	1	2
7	CSS52	Data Structure and Algorithms Laboratory	0	0	3	2	3
8	XES52	Basic Electrical and Electronics Engineering Laboratory	0	0	3	2	3
		TOTAL	**13**	**2**	**8**	**20**	**23**

Semester - III							
Sl. No.	**Code**	**Subject**	**L**	**T**	**S**	**C**	**H**
1	MAC331	Mathematics - III	3	1	0	4	4
2	CYC301	State of Matter and Chemical Thermodynamics	3	1	0	4	4
3	CYC302	Atomic Structure and Chemical Bonding	3	0	0	3	3
4	CYC303	Stereochemistry and Basic Principle of Organic Chemistry	3	0	0	3	3
5	PHC334	Physics II	3	0	0	3	3
6	PHS384	Physics II Laboratory	0	0	3	2	3

7	CYS351	Qualitative Analysis of Organic Samples Laboratory	0	0	3	2	3
		TOTAL	**15**	**2**	**6**	**21**	**23**
Semester - IV							
Sl. No.	**Code**	**Subject**	**L**	**T**	**S**	**C**	**H**
1	CYC401	Biochemistry: Structure and Function	3	0	0	3	3
2	CYC402	Phase-Equilibrium and Chemical Kinetics	3	1	0	4	4
3	CYC403	Chemistry of Elements and Radioactivity	3	1	0	4	4
4	CYC404	Organic Reaction Mechanism and Reactive Intermediates	3	1	0	4	4
5	CYE411/ CYE412	Departmental Elective 1	3	0	0	3	3
6	CYS451	Thermodynamic Properties of Solution and Mixture Laboratory	0	0	4	2	4
7	CYS452	Identification of Acidic and Basic Radicals Laboratory	0	0	4	2	4
8	CYS453	Biochemistry Laboratory	0	0	3	2	3
		TOTAL	**15**	**3**	**11**	**24**	**29**
Semester - V							
Sl. No.	**Code**	**Subject**	**L**	**T**	**S**	**C**	**H**
1	CYC501	Fundamentals of Electrochemistry and Data Analysis	3	1	0	4	4
2	CYC502	Chemistry in Solution and Solid State Chemistry	3	1	0	4	4
3	CYC503	Chemistry of Heterocyclic Compounds	3	0	0	3	3
4	CYC504	Industrial Chemistry	3	0	0	3	3
5	CYC505	Ionic Equilibria and Surface Chemistry	3	0	0	3	3
6	CYS551	Chemical Kinetics, Surface Chemistry and ConductometricAnalysis	0	0	3	2	3
7	CYS552	Quantitative Estimation of Metal Ions in Mixture	0	0	4	2	4
8	CYS553	Quantitative Analysis of Organic Samples	0	0	3	2	3
		TOTAL	**15**	**2**	**10**	**23**	**27**
Semester - VI							
Sl. No.	**Code**	**Subject**	**L**	**T**	**S**	**C**	**H**
1	CYC601	Basics of Photochemistry, Spectroscopy and Group Theory	3	1	0	4	4
2	CYC602	Coordination Chemistry	3	1	0	4	4
3	CYC603	Reagents in Organic Synthesis	3	1	0	4	4
4	HSC631	Economics and Management Accountancy	3	0	0	3	3
5	CSC631	Artificial Intelligence & Machine Learning	3	0	2	4	5
6	CYS651	Potentiometric and Colorimetric Analysis	0	0	3	2	3

7	CYS652	Analysis of Ores and Alloys	0	0	4	2	4
8	CYS653	Single Step Organic Synthesis Laboratory	0	0	4	2	4
		TOTAL	**15**	**3**	**13**	**25**	**31**
Semester - VII							
Sl. No.	**Code**	**Subject**	**L**	**T**	**S**	**C**	**H**
1	MSC731	Principles of Management	3	0	0	3	3
2	CYC701	Quantum Chemistry	3	1	0	4	4
3	CYC702	Inorganic Reaction Mechanisms and Magnetochemistry	3	1	0	4	4
4	CYC703	Concept of Organic Synthesis and Asymmetric Synthesis	3	1	0	4	4
5	YYO74*	Open Elective	3	0	0	3	3
6	CYS751	Spectrophotochemical Analysis	0	0	3	2	3
7	CYS752	Spectrophotometric Estimation of Cations and Anions	0	0	3	2	3
8	CYS753	Identification of Organic Compounds from Binary Mixture	0	0	4	2	4
		TOTAL	**15**	**3**	**10**	**24**	**28**
Semester - VIII							
Sl. No.	**Code**	**Subject**	**L**	**T**	**S**	**C**	**H**
1	CYC801	Chemical, Statistical Thermodynamics and Electrochemistry	3	1	0	4	4
2	CYC802	Organometallic Compounds and Bioinorganic Chemistry	3	1	0	4	4
3	CYC803	Pericyclic Reactions and Organic Photochemistry	3	1	0	4	4
4	CYC804	Spectroscopy: Theory and Applications	3	1	0	4	4
5	CYE811/ CYE812	Departmental Elective 2	3	0	0	3	3
6	CYS851	Advanced Practical on Physical Chemistry	0	0	4	2	4
7	CYS852	Synthesis and Characterisation of Inorganic Complexes	0	0	3	2	3
8	CYS853	Chromatographic Separation of Organic Compounds	0	0	3	2	3
		TOTAL	**15**	**4**	**10**	**25**	**29**
Semester - IX							
Students to choose all four (04) DEPTH elective courses from a particular specialization and one (01) DEPTH elective course from other two specialization baskets							
Sl. No.	**Code**	**Subject**	**L**	**T**	**S**	**C**	**H**
Physical Chemistry Specialization							
1	CYE911	Advanced Quantum and Computational Chemistry	3	0	0	3	3

2	CYE912	Basics of Non-linear Dynamics	3	0	0	3	3
3	CYE913	Advanced Spectroscopic Techniques and Applications of Group Theory	3	0	0	3	3
4	CYE914	Surface Science, Electrode Kinetics and Corrosion Science	3	0	0	3	3
OR							
Inorganic Chemistry Specialization							
1	CYE921	Advanced Green Chemistry and Environmental Chemistry	3	0	0	3	3
2	CYE922	Synthetic Methodology for Metal Complexes and Coordination Aggregates	3	0	0	3	3
3	CYE923	Small Molecule Activation, Nuclear Chemistry and Related Spectroscopy	3	0	0	3	3
4	CYE924	Application of Group Theory and Applied Electrochemistry	3	0	0	3	3
OR							
Organic Chemistry Specialization							
1	CYE931	Advanced Organic Synthesis	3	0	0	3	3
2	CYE932	Drug Design and Biophysical Chemistry	3	0	0	3	3
3	CYE933	Bioorganic Chemistry & Natural Products	3	0	0	3	3
4	CYE934	Advanced Stereochemistry and Structure Activity Correlation	3	0	0	3	3
5	CYS954	Project I	0	0	3	1	3
6	CYS955	Summer Internship	0	0	0	1	0
		TOTAL	**15**	**0**	**3**	**17**	**18**

Semester - X

Sl. No.	Code	Subject	L	T	S	C	H
1	CYS1051	Project II	0	0	30	6	30
2	CYS1052	Comprehensive Viva	0	0	0	1	0
		TOTAL	**0**	**0**	**30**	**7**	**30**

CREDIT UNIT OF THE PROGRAM

Semester	I+II	III	IV	V	VI	VII	VIII	IX	X	Total
Credit units	43	21	24	23	25	24	25	17	7	209

DEPTH ELECTIVE COURSE BASKETS

THE STUDENTS PRIMARILY WILL OPT FROM THE DEPTH ELECTIVE SUBJECT(S) THAT ARE OFFERED IN A PARTICULAR SEMESTER BY HIS/ HER OWN DEPARTMENT. HOWEVER, A STUDENT CAN OPT FOR DEPTH ELECTIVE SUBJECT(S) THAT ARE OFFERED BY OTHER DEPARTMENT IN A PARTICULAR SEMESTER, WITH THE PERMISSION/ CONSENT FROM HIS/ HER HEAD OF THE DEPARTMENT AND THE CONCERNED TEACHER OF THAT SUBJECT.

Departmental Electives for Semester IV							
1	CYE411	Analytical and Environmental Chemistry	3	0	0	3	3
2	CYE412	Chromatographic Separation and Instrumental Methods of Analysis	3	0	0	3	3
Departmental Electives for Semester VIII							
1	CYE811	Chemistry of Materials: Synthesis, Structure and Application	3	0	0	3	3
2	CYE812	Molecular Modelling in Chemistry	3	0	0	3	3

DETAILED SYLLABUS

FIRST YEAR

			Total number of contact hours				
Course code	Title of the course	Program Core (PCR)/Electives (PEL)	Lecture (L)	Tutorial (T)	Practical (P)	Total hours	Credit
MAC01	**Mathematics– I**	PCR	3	1	0	4	4
Pre-requisites		Basic concepts of function, limit, differentiation and integration					
Course outcomes	**CO1**: Learn the fundamentals of differential calculus of single and several variables. **CO2**: Learn the basic concepts of convergence of infinite series. **CO3**: Understand the basic concepts of integral calculus along with its various applications. **CO4**: Acquire the theoretical knowledge of vector calculus and its engineering applications.						
Topics covered	**Functions of Single Variable:** Review of limit, continuity and differentiability. Mean value theorems: Rolle's Theorem, Lagrange's Mean Value Theorem (MVT), Cauchy's MVT, Taylor's theorem, Taylor's and Maclaurin's series. (8 L) **Functions of Several Variables:** Limit, continuity and differentiability of functions of several variables, partial derivatives and their geometrical interpretation, derivatives of composite and implicit functions, derivatives of higher order and their commutativity, Homogeneous function, Euler's theorem and its converse, Exact differential, Jacobian, Taylor's & Maclaurin's series, Maxima and Minima, Necessary and sufficient condition for maxima and minima (no proof). (11 L) **Sequences and Series:** Real sequences and their convergence, Series of positive terms, Necessary and sufficient condition for convergence, p-series, geometric series, Comparison test, D Alembert's ratio test, Cauchy's root test, Alternating series, Leibnitz's rule, Absolute and conditional convergence. (6 L) **Integral Calculus:** Review of the idea of integration as a limit of a sum, Mean value theorems of integral calculus, Area and length in Cartesian and polar co-ordinates, Volume and surface area of solids of revolution in Cartesian and polar forms, Improper integrals and their convergence, Beta and Gamma functions. (12 L) **Multiple Integrals:** Evaluation of double and triple integrals, Change of order of integration, Change to better coordinates, Area and volume by double integration, Volume by triple integration. (10 L) **Vector Calculus:** Vector valued functions and its differentiability, Line integral, Surface integral, Volume integral, Gradient, Curl, Divergence, Green's theorem in the plane (including vector form), Stokes' theorem, Gauss's divergence theorem and their engineering applications. (9 L)						

Text Books, and/or reference materials	**Text Books:** 1. Kreyszig, E., Advanced Engineering Mathematics: 10th edition, Wiley India Edition, 2010. 2. Murray, D.A., Differential and Integral Calculus, FB & C Limited, 2018. 3. Marsden, J. E; Tromba, A. J.; Weinstein: Basic Multivariable Calculus, Springer, 2014. 4. Murray Spiegel, Schaum's Outline of Vector Analysis, ata McGraw Hill T .Education, 1980 **Reference Books:** 1. Tom Apostal, Calculus-Vol-I & II, Wiley Student Edition, 2011. 2. Thomas and Finny: Calculus and Analytic Geometry, 11th Edition, Addison Wesley.

Mapping of COs (Course Outcomes) and POs (Programme Outcomes)

Course	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
MAC01	CO1	2	3	2	3	1	1	-	-	1	1	1	2
	CO2	2	3	2	3	-	1	-	-	1	1	2	2
	CO3	2	3	2	3	-	1	1	-	-	2	2	2
	CO4	3	3	2	3	1	1	-	1	-	2	1	2

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CSC01	**Computer Programming**	PCR	2	1	0	3	3
Pre-requisites		Course Assessment methods [Continuous (CT), mid-term (MT) and end assessment (EA)]					
Basic knowledge of computer		CT+MT+EA					
Course Outcomes	**CO1**: To understand basics of computer programming, program flow, and programming constructs. **CO2**: Develop concepts on basic and complex data types, conditional and iterative statements. **CO3**: Exercise the concepts of user defined functions to solve real time problems. **CO4**: Inscribe C programs that use Pointers to access arrays, strings and functions. **CO5**: Exercise user defined data types including structures and unions to solve problems.						
Topics Covered	**Introduction to C**: Phases of developing a running computer program in C. (2L) Data types, size and values. Char, Unsigned and Signed data types. Number systems and representations. Constants, Overflow. (3L) Data concepts in C: Constants, Variables, Expressions, Operators, and operator precedence in C. (2L) Statements: Declarations, Input-Output Statements, Compound statements, Selection Statements. (2L) Conditions, Logical operators, Precedences. Repetitive statements, While construct, Do-while Construct, For construct. (3L) Arrays. Strings. Multidimensional arrays and matrices. (3L) **Pointers:** Pointer variables. Declaring and dereferencing pointer variables. Pointer Arithmetic. Examples. Accessing arrays through pointers. Pointer types, Pointers and strings. String operations in C. (6L)						

	Dynamic memory allocation. (2L) **Modular Programming:** Functions: The prototype declaration, Function definition. (3L) Function call: Passing arguments to a function, by value, by reference. Scope of variable names. Recursive function calls, Tail recursion. (4 L) Sorting problem: Sorting in arrays with an example of Bubble sort. Sorting in strings. (3L) Search problem: Linear search and binary search. (2 L) **More Data-types in C:** Structures in C: Motivation, examples, declaration, and use. Operations on structures. Passing structures as function arguments. type defining structures. (4L) File input-output in C. Streams. Input, output and error streams. Opening, closing and reading from files. Programming for command line arguments. (3 L)
Text Books, and/or reference material	**Text Books:** 1. P. Deitel, H. Deitel. C How to Program. Pearson Education India, 7th Ed. 2. B. W. Kernighan, Dennis M. Ritchie. The C Programming. Prentice Hall Software Series, 2nd Ed. **Reference Books:** 1. P. Dey and M. Ghosh. Computer fundamentals and programming in C. Oxford press, 2013. 1. Y. Kanetkar. Let Us C. BPB Publications, Sixteenth edition, 2017.

Mapping of COs (Course Outcomes) and POs (Programme Outcomes)

Course	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CSC01	CO1	2	2	1	-	1	2	-	-	-	-	-	-
	CO2	3	2	1	-	1	1	1	-	-	-	-	-
	CO3	2	2	1	-	-	2	-	-	-	-	-	-
	CO4	3	2	2	-	-	1	-	-	-	-	-	-
	CO5	3	1	2	-	1	2	-	-	-	-	-	-

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
XEC01	**Engineering Mechanics**	PCR	2	1	0	3	3
Pre-requisites		Course Assessment methods [Continuous (CT), mid-term (MT) and end assessment (EA)]					
		CT+MT+EA					
Course Outcomes	**CO1**: Acquire knowledge of mechanics and ability to draw free body diagrams. **CO2**: Apply knowledge of mechanics for solving special problems like truss and frame analysis. **CO3**: Ability to calculate centroid, moments of inertia for various shapes. **CO4**: Learn momentum and energy principles. **CO5**: Knowledge on virtual Work Principle and its application.						
Topics Covered	Engineering Mechanics; measurement and SI units. [1 L] Vectors and force as a vector; Resultant of a system of forces on a particle; free body diagram and conditions of equilibrium of a particle; problems on particles; equilibrium of particles in space. [2 L] Resultant of a system of forces and couples on a rigid body; conditions of equilibrium of a rigid body; free body diagrams of rigid bodies subjected to						

	different types of constraints; simple space problems of rigid bodies. [4 L] Coefficients of static and kinetic friction; problems involving friction; theories of friction on square threaded power screw and flat belt. [5 L] Simple trusses; analysis of trusses by method of joints and method of sections.[5 L] Centre of gravity and centre of mass; centroids of lines, curves and areas; first moment of area; second moment of area; polar moment of inertia; radius of gyration of an area; parallel axis theorem; mass moment of inertia. [4 L] Path, velocity, acceleration; rectilinear and curvilinear motion; motion of system of particles; introduction to the concept of plane kinematics of rigid bodies. [6 L] Newton's second law of motion; dynamic equilibrium and D'Alembert's principle; linear momentum; angular momentum; rectilinear and curvilinear motion; principles of work–energy and impulse–momentum; impact of system of particles; introduction to the concept of plane kinetics of rigid bodies. [12 L] Principle of Virtual Work, Solution of Problems on Mechanics using Principle of Virtual Work.[3 L]
Text Books, and/or reference material	1) S. P. Timoshenko and D. H. Young, Engineering Mechanics, 5th Edition 2) J. L. Meriam and L. G. Kraige, Engineering Mechanics, 5th Edition, Wiley India 3) F. P. Beer and E. R. Johnston, Vector Mechanics for Engineers 4) I. H. Shames, Engineering Mechanics

Mapping of COs (Course Outcomes) and POs (Programme Outcomes)

Course	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
XEC01	CO1	1	-	-	-	-	-	-	-	-	-	-	1
	CO2	1	1	1	1	-	-	-	-	-	-	-	1
	CO3	1	1	-	-	-	-	-	-	-	-	-	1
	CO4	1	2	-	-	-	-	-	-	-	-	-	1
	CO5	-	2	2	2	2	1	-	-	-	1	-	1

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
PHC01	**Engineering Physics**	PCR	2	1	0	3	3
Pre-requisites		Course Assessment methods: [Continuous (CT), mid-term (MT) and end assessment (EA)]					
NIL		CT+MT+EA					
Course Outcomes	**CO1**: To realize and apply the fundamental concepts of physics such as superposition principle, simple harmonic motion to real world problems. **CO2**: Learn about the quantum phenomenon of subatomic particles and its applications to the practical field. **CO3**: Gain an integrative overview and applications of fundamental optical phenomena such as interference, diffraction and polarization. **CO4**: Acquire basic knowledge related to the working mechanism of lasers and signal propagation through optical fibers.						
Topics Covered	**Harmonic Oscillations** - Linear superposition principle, Superposition of two perpendicular oscillations having same and different frequencies and phases, Free, Damped and Forced vibrations, Equation of motion, Amplitude resonance, Velocity						

	resonance, Quality factor, sharpness of resonance. [8 L] **Wave Motion**: Longitudinal waves, Transverse waves, Wave equation, phase velocity and group velocity, Maxwell's equations, Electro-magnetic waves in free space. [3 L] **Introductory Quantum Mechanics** - Inadequacy of classical mechanics, Blackbody radiation, Planck's quantum hypothesis, de Broglie's hypothesis, Heisenberg's uncertainty principle and applications, Schrodinger's wave equation and applications to simple problems: Particle in a one-dimensional box, Simple harmonic oscillator, Tunnelling effect. [8 L] **Interference & Diffraction** - Huygens' principle, Young's experiment, Superposition of waves, Conditions of sustained Interference, Concepts of coherent sources, Interference by division of wavefront, Interference by division of amplitude with examples, The Michelson interferometer and some problems; Fraunhofer diffraction, Single slit, Multiple slits, Resolving power of grating. [13 L] **Polarisation** - Polarisation, Qualitative discussion on Plane, Circularly and elliptically polarized light, Malus law, Brewster's law, Double refraction (birefringence) - Ordinary and extra-ordinary rays, Optic axis etc.; Polaroid, Nicol prism, Retardation plates and analysis of polarized lights. [5 L] **Laser and Optical Fiber** - Spontaneous and stimulated emission of radiation, Population inversion, Einstein's A & B co-efficient, Optical resonator and pumping methods, He-Ne laser. Optical Fibre– Core and cladding, Total internal reflection, Calculation of numerical aperture and acceptance angle, Applications. [5 L]
Text Books, and/or reference material	**TEXT BOOKS**: 1. The Physics of Vibrations and Waves, H. John Pain, Willy and Sons 2. A Text Book of Oscillations and Waves, M. Goswami and S. Sahoo, Scitech Publications 3. Engineering Physics, H. K. Malik and A. K. Singh, McGraw-Hill. **REFERENCE BOOKS**: 1. Vibrations and Waves in Physics, Iain G. Main, Cambridge University Press 2. Quantum Physics, R. Eisberg and R. Resnick, John Wiley and Sons 3. Fundamental of Optics, Jankins and White, McGraw-Hill 4. Optics, A. K. Ghatak, Tata McGraw-Hill 5. Waves and Oscillations, N. K. Bajaj, Tata McGraw-Hill 6. Lasers and Non-linear Optics, B. B. Laud, New Age International Pvt Lt

Mapping of COs (Course Outcomes) and POs (Programme Outcomes)

Course	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
PHC01	CO1	3	2	1	1	1	-	-	1	-	-	-	1
	CO2	3	2	-	2	-	-	-	-	-	-	-	1
	CO3	3	2	2	2	1	1	1	1	1	-	1	1
	CO4	3	2	2	2	1	1	1	-	1	-	1	1

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CYC01	**Engineering Chemistry**	PCR	3	0	0	3	3
Pre-requisites		Course Assessment methods [Continuous (CT), mid-term (MT) and end assessment (EA)]					
None		CT+MT+EA					

CURRICULUM AND SYLLABUS FOR INTEGRATED MSC IN CHEMISTRY

Course Outcomes	**CO1**: Students will get the knowledge of fundamentals as well industrial applications of polymer, petroleum products, organometallic compounds and others. **CO2**: Students will be able to elucidate the structure of different organic compounds and to analyze the structure-property correlation. **CO3**: Students will be aware on the role played by different metals in biological systems and also the ecological impact of metals. **CO4**: Students will be able to understand and analyze thermodynamical, kinetic as well as electrochemical aspects of chemical systems and apply the understanding in the technical field.
Topics Covered	**ORGANIC CHEMISTRY** i. **Polymer chemistry and polymer engineering:** Fundamental concept on polymer chemistry; synthesis and application of important polymers, Rubber and plastic materials; vulcanization, structure-property correlation: Concept of Molecular weight of polymer, Glass transition temperature. Engineered polymer: Thermally stable, flame retardant, Conducting polymer. (5L) ii. **Petroleum Engineering and oil refinery:** Origin of petroleum, separation principle and techniques of distillation of crude oil, thermal and catalytic cracking of petroleum, uses of different fractions, knocking, anti-knock compounds, octane number and cetane number. High octane and Aviation fuel. Bio-diesel. (3L) iii. **Structure elucidation of organic compounds by modern spectroscopic methods:** Application of UV-Visible (Lambert-Beers law), concept of chromophore, auxochrome, hypso-, hyper-, bathochromic, red shift. FT-IR spectroscopy and Mass spectroscopy (including instrumentation). (4L) **INORGANIC CHEMISTRY** i. **Coordination Chemistry:** Crystal Field Theory of octahedral and tetrahedral complexes, colour and magnetic properties, LMCT, MLCT, IVCT. Isomerism and stereochemistry.(5L) ii. **Bioinorganic Chemistry:** Metal ions in biological systems: Fe, Cu.(2L) iii. **Industrial Applicationof Organometallic Complexes:** π-acid ligands, stabilization of metal low oxidation state and 18 electron rules, metal carbonyls and nitrosyls, metal-alkene complexes, Various catalytic cycles of industrial importance. (4L) iv. **Environmental Chemistry:** Metal toxicity (As, Hg, Pb and Cd) and its remediation.(1L) **PHYSICAL CHEMISTRY** i. **Chemical Thermodynamics:** 2nd law of thermodynamics: Concept of thermodynamic engine (Carnotand reverse Carnot cycle), entropy, free energy. Temperature and pressure dependence of entropy and free energy. Change in phase: phase diagram of single component system. Cryogenics: Joule Thomson experiment. (5L) ii. **Chemical Kinetics:**Rate expression of Reversible reaction, parallel reaction,and Consecutive reaction with proper examples. Temp effect on reaction rate.(3L) iii. **Catalysis:** Types of catalysis, Rate expression for Catalysed reaction, Acid-base and Enzyme catalysis.(2L) iv. **Electrochemistry:**EMF, Nernst Equation, Application of electrochemistry in chemical processes. Electrochemical cell, Fuel cell, Li-ion battery. (3 L)
Text Books, and/or reference material	Suggested Text Books: (i) Physical Chemistry by P. Atkins, Oxford (ii) A guidebook to mechanism in Organic chemistry: Peter Sykes; Pearson Edu. (iii) Inorganic Chemistry Part-I & II, R. L. Dutta, The new book stall Suggested Reference Books: **Organic Chemistry**: (i) Basic stereochemistry of organic molecules: S. Sengupta; Oxford University press

	(ii) Engineering Chemistry: Wiley (iii) Elementary Organic Spectroscopy: William Kemp, ELBS with Macmillan **Inorganic Chemistry:** (i) Inorganic Chemistry: Principle structure and reactivity, J. E. Huheey, E. A. Keiter and R. L. Keiter, Pearson Education (ii) Bioinorganic Chemistry -- Inorganic Elements in the Chemistry of Life: An Introductionand Guide, 2nd Edition, Wolfgang Kaim, Brigitte Schwederski, Axel Klein. (iii) Inorganic Chemistry Fourth Edition, Shriver & Atkins, Oxford **Physical Chemistry:** (i) Physical Chemistry by G.W Castellan (ii) Physical Chemistry by P. C. Rakshit

Mapping of COs (Course Outcomes) and POs (Programme Outcomes)

Course	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CYC01	CO1	1	2	-	-	-	-	-	-	-	-	-	-
	CO2	1	-	-	-	-	-	2	-	-	-	-	-
	CO3	1	2	1	1	1	-	-	-	-	-	-	-
	CO4	-	1	-	-	2	-	1	-	-	-	-	-

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
ESC01	**Ecology and Environment**	PCR	2	0	0	2	2
Pre-requisites		Course Assessment methods [Continuous (CT), mid-term (MT) and end assessment (EA)]					
NIL		CT+MT+EA					
Course Outcomes	**CO1**: Understand the importance of environment and ecosystem. **CO2**: Understand the fundamental aspect of pollutant tracking and its implementation in natural and anthropogenic pollution of air and water system. **CO3**: Understand the scientific basis of local and as well as global issues. **CO4**: Apply of knowledge to develop sustainable solution.						
Topics Covered	**UNIT – I: INTRODUCTION** (2 L) Multidisciplinary nature of Environmental Studies: Definition, Scope, and Importance. **UNIT–II: FUNDAMENTALS OF ECOLOGY** (9 L) Definition, Components of Environment; Fundamentals of Ecology and Ecosystem; Components and Classification of Ecosystem; Energy flow in Ecosystem: Tropic level, Food Chain, Food Web, Ecological Pyramid; Biogeochemical cycles: Carbon, Nitrogen, Sulphur, Phosphorus, and Water Cycle; Biosphere and Biodiversity; Conservation. **UNIT–III: FUNDAMENTALS OF ENVIRONMENT** (10 L) **Environmental Pollution:** Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution, Solid Wastes, and Natural hazards: Floods, earthquakes, cyclones, and landslides. **Environmental Issues:** Climate change and global warming; acid rain; and ozone layer depletion.						

	Environment Quality: Ambient air quality standards, Water quality parameters and standards: pH, Turbidity, Hardness, Sulphate, Phosphates, Iron, Dissolved Oxygen, BOD, and COD. **UNIT– IV: NATURAL RESOURCES** (3 L) Mineral Resources, Energy Resources: Conventional and Non-Conventional. **UNIT- V- GREEN TECHNOLOGY & ENVIRONMENTAL ETHICS** (4 L) Sustainability: Carbon Sequestration, Green building practices, Green computing; Carrying capacity; and Environment Protection Acts/laws.
Text Books, and/or reference material	1. A Basic Course in Environmental Studies. Deswal & Deswal. Pub. Dhanpat Rai & Sons 2. Ecology. Odum. Pub. Oxford & IBH 3. Environmental Engineering. Peany et.al. Pub. McGraw Hill 4. A Text Book of Environmental Engg. Venugpal Rao. Pub. PHI 5. A Basic Course in Environmental Studies. Deswal & Deswal. Pub. Dhanpat Rai & Sons 6. Environmental Studies. Bharucha. Pub. University of Press 7. Environmental Chemistry and Pollution, S. S. Dara & D. D. Mishra, S. Chand Publishing

Mapping of COs (Course Outcomes) and POs (Programme Outcomes)

Course	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
ESC01	CO1	3	-	-	-	-	-	2	-	-	-	-	-
	CO2	1	-	-	-	-	-	2	-	-	-	-	-
	CO3	2	-	-	-	-	-	2	-	-	-	-	-
	CO4	1	-	3	-	-	2	1	-	-	-	-	-

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
HSC01	**Professional Communication**	PCR	2	0	2	4	3
Pre-requisites		Course Assessment methods [Continuous (CT) and end assessment (EA)]					
None		CT+EA					
Course Outcomes	**CO1**: Learners will acquire linguistic proficiency in terms of improvement in their listening, speaking, reading, and writing skills. **CO2**: Learners will acquire better communicative ability. **CO3**: The course will help learners improve their social connectivity skill.						
Topics Covered	Vocabulary 1. Word Formation, Use of Prefixes and Suffixes (1) 2. Synonyms, Antonyms (1) 3. Prefixes and Suffixes from Foreign Languages, Words from Foreign Languages (1) 4. Abbreviations and Acronyms (1) 5. Technical Vocabulary (1) Grammar						

	1. Identifying Common Errors in Articles and Prepositions (1) 2. Common Errors in Noun-Pronoun Agreement and Subject-Verb Agreement (1) 3. Misplaced Modifiers and Tenses (1) 4. Redundancies and Clichés (1) Reading 1. Reading and Its Importance, Techniques of Effective Reading (1) 2. Improving Comprehension Skills, Techniques for Good Comprehension (1) 3. Skimming and Scanning (1) 4. Comprehension, Intensive and Extensive Reading (2) Writing 1. Sentence Structures, Phrases and Clauses, Punctuation (2) 2. Organising Principles of Paragraphs (2) 3. Formal Letters, Letters of Complaint, Requisition Letters, Job Application, and Résumé (2) 4. Nature and Style of Sensible Writing, Defining, Describing, Classifying, Providing Examples and Evidence (2) 5. Essay Writing (2) 6. Précis Writing (2) 7. Report Writing (2) Oral Communication 1. Listening Comprehension (4) 2. Pronunciation, Intonation, Stress, and Rhythm (4) 3. Communication at the Workplace (4) 4. Everyday Conversation (4) 5. Group Discussion (4) 6. Interviews (4) 7. Formal Presentations (4)
Text Books, and/or reference material	**Text Book:** 1. English for Engineers –Sudharshana & Savitha (Cambridge UP) **Reference Books:** 2. *English*—Kulbhushan Kumar (Khanna Book Publishing) 3. *Remedial English Grammar*—F. T. Wood (Macmillan)

Mapping of COs (Course Outcomes) and POs (Programme Outcomes)

Course	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
HSC01	**CO1**	1	--	--	1	--	1	--	1	2	3	1	--
	CO2	1	--	--	1	--	2	--	2	2	3	2	--
	CO3	--	--	--	1	--	3	--	3	3	3	2	--

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
MAC02	**Mathematics - II**	PCR	3	1	0	4	4
Pre-requisites		Course Assessment methods [Continuous (CT), mid-term (MT) and end assessment (EA)]					
Basic concepts of set theory, differential equations, and		CT+MT+EA					

probability.	
Course Outcomes	**CO1**: Learn the basic concepts of linear algebra and be able to apply the same to solve various engineering problems. **CO2**:Understand fundamentals of ordinary differential equations and their applications. **CO3**:Acquire the theoretical knowledge of Fourier Series, Fourier & Laplace transforms, and learn about their applications. **CO4**: Learn the basic concepts of probability theory.
Topics Covered	**Introduction to Algebraic structures:** Group, subgroup, ring, subring, integral domain, and field.(3 L) **Linear Algebra:** Vector spaces over field, linear dependence and independence of vectors, linear span of a set of vectors, basis and dimension of finite dimensional vector space, elementary row/column operations, rank of a matrix, solutions of system of linear (homogeneous and non-homogeneous) equations, eigenvalues and eigenvectors, characteristic polynomials, Cayley-Hamilton theorem (without proof), Diagonalization of matrices. (15 L) **Ordinary Differential Equations (ODE):** Review of first order ODE, Picard's theorem (Statement Only), ODE of first order and of the first degree (exact ODE, rules for finding integrating factors), ODE of first order and of the higher degree (ODE solvable for x, solvable for y; Clairaut's equation, singular solution), homogeneous and non-homogeneous linear ODE with constant coefficients and variable coefficients (Euler–Cauchy type), linear dependence of solutions, Wronskian determinant, Solution of simultaneous ODEs $(dx/P = dy/Q = dz/R;\ dx/dt = ax + by,\ dy/dt = cx + dy)$, properties of nonlinear ODEs, phase plane analysis. (18 L) **Fourier series:** Piecewise smooth and periodic functions, Fourier series of a function in an interval, Dirichlet conditions, Convergence of Fourier series, Fourier sine and cosine series, Complex form of Fourier series. (4 L) **Fourier Transforms:** Fourier Integral Theorem (statement only), Different forms of Fourier Integrals, Fourier Transform and its inversion formula, Properties of Fourier Transform, Convolution. (7 L) **Laplace Transforms:** Laplace transforms and its Properties, Inverse Laplace transforms, Convolution theorem, Applications to ODE. (4 L) **Probability:** Random variables and probability distributions (discrete and continuous), Binomial, Poisson, Uniform and Normal distributions.(5 L)
Text Books, and/or reference material	**Text Books:** 1. Kreyszig, E., Advanced Engineering Mathematics: 10th edition, Wiley India Edition (2010). 2. Strang, G., Linear algebra and its applications (4th Edition), Thomson (2006). 3. Murray, D.A., Introductory Course in Differential Equations, Khosla Publishing House (2021). 4. Debnath, L., Integral Transforms and Their Applications, CRC Press (1995). 5. Baisnab, A.P., Jas, M., Elements of Probability and Statistics, McGraw Hill Education (2017). **Reference Books:** 1. Kumaresan, S., Linear algebra - A Geometric approach, Chaukhamba Auriyantaliya (2017). 2. Ross, S.L., Differential Equations, 3rd Edition, Wiley Student Edition (2017). 3. Shivamoggi, A., Integral Transforms for Engineers, PHI (2003). 4. Grinstead, C.M., Snell, J.L., Introduction to probability, American Mathematical Society (2012).

Mapping of COs (Course Outcomes) and POs (Programme Outcomes)

Course	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
MAC02	CO1	3	3	2	1	2	-	2	-	-	-	1	2
	CO2	3	3	2	2	2	-	2	-	-	1	-	2
	CO3	3	3	2	2	3	1	1	-	1	1	1	2
	CO4	3	2	1	3	2	1	1	1	1	-	-	2

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CSC02	**Data Structure and Algorithms**	PCR	2	1	0	3	3
Pre-requisites		Course Assessment methods [Continuous (CT), mid-term (MT) and end assessment (EA)]					
CSC01 (Computer Programming)		CA+ MT + ET					
Course Outcomes	**CO1**: Understanding the fundamental concepts of abstract data types, data structures, algorithms and time complexity analysis of algorithms. **CO2**: Implementation of different abstract data types (array, linked list, stack, queue, tree, graph). **CO3**: Implementation of different sorting and searching techniques along with their performance evaluation. **CO4**: Analysis of the suitability/compatibility of different data structures based on the types of applications. **CO5**: Design and development of algorithms for real-life applications.						
Topics Covered	**Introduction:** Abstract Data Type (ADT), Data Structures, Concept of static and dynamic memory allocation, Algorithm, Analysis of time and space complexity of algorithms, Asymptotic notations: Big Oh, Big Omega and Big Theta notations, Impact of data structure on the performance of an algorithm. (6L) **Array:** Array as an ADT, Single and multi-dimensional array, Memory representation (row major and column major) of array, Address calculation for array elements. (2L) **Linked list:** Linked list as an ADT, Memory allocation and deallocation for a linked list, Linked list versus array, Types of linked lists: singly linked list, doubly linked list and circular linked list, Operations on linked list: creation, display, insertion and deletion (in different positions), Concatenation, Searching, Sorting, Applications of linked list: Representations and operations on polynomials, sparse matrices, etc., Array vs. Linked List. (6L) **Stack:** Stack as an ADT, Push and pop operations on stacks, Array implementation of stack, Linked list implementation of stack, Applications of stack: Recursion, Function call, Evaluation of postfix expression using stack, Conversion of infix to postfix using stack. (5L) **Queue:** Queue as an ADT, Enqueue and dequeue operations, Array implementation of queue, Limitation of array implementation, Circular queue, Linked list implementation of queue, Priority queue. (4L) **Binary Tree:** Binary Tree, Definition and properties, Representation of binary tree in memory: linked representation, array representation, Binary tree traversal (Preorder, Inorder and Postorder), Binary search tree, Heap (8L) **Searching Algorithms:** Linear search and binary search. (2L) Sorting Algorithms: Selection sort, Insertion sort, Quick sort, and Merge sort. (5L)						

	Graphs Algorithms: Graph representation using Adjacency matrix and Adjacency list, Breadth First Search and Depth First Search algorithms. (4L)
Text Books, and/or reference material	**Text Books:** 1. R. F. Gilberg and B. A. Forouzan, "Data Structures: A pseudocode approach with C", 2nd Edition, CENGAGE Learning. 2. A. V. Aho, J. D. Ullman and J. E. Hopcroft, “Data Structures and Algorithms”, Addition Wesley. 3. Lipschutz, “Data Structures (Schaum’s Outline Series)”, Tata Mcgraw Hill. 4. E. Horowitz, S. Sahni, S. Anderson-Freed, “Fundamentals of Data Structures in C”, Universities Press; Second edition (2008). **Reference Books:** 1. Y. Langsam, M. J. Augenstein and A. N. Tanenbaum, "Data Structures using C and C++", Pearson, 2006. 2. Knuth, Donald E. The Art of Computer Programming. 3rd ed. Vols 1&2. Reading, MA: Addison-Wesley, 1997. ISBN: 0201896834. ISBN: 0201896842. ISBN: 0201896850. 3. Kleinberg and Eva Tardos. Algorithm Design. Addison-Wesley 2005 ISBN-13: 978-0321295354.

Mapping of COs (Course Outcomes) and POs (Programme Outcomes)

Course	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CSC02	CO1	3	-	1	1	1	-	-	-	-	-	-	-
	CO2	3	2	1	2	2	-	-	-	-	-	-	1
	CO3	3	2	1	2	2	-	-	-	-	-	-	1
	CO4	3	3	2	3	3	-	-	-	-	-	-	1
	CO5	3	3	3	3	3	-	-	-	-	-	-	2

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
XEC02	**Basic Electrical and Electronics Engineering**	PCR	3	0	0	3	3

Pre-requisites	Course Assessment methods [Continuous (CT), mid-term (MT) and end assessment (EA)]
(10+2) level mathematics and physics	CT+MT+EA

Course Outcomes	**CO1**: Learn the fundamentals of electric circuits and analyze the circuits using laws and network theorems. **CO2**: Gain the knowledge about magnetic circuits, electromagnetism and the basics of generation of alternating voltage. **CO3**: Understand the behaviour of single phase and poly-phase AC circuits. **CO4**: Understand the fundamentals of semiconductor devices. **CO5**: Analyze the design and characteristics of transistor-based electronic circuits. **CO6**: Evaluate operational amplifier-based circuits and logic gates.
Topics Covered	1. Introduction to Electrical systems, Fundamentals of Electric Circuits: Ohm’s laws, Kirchhoff’s laws, Independent and Dependent sources, Analysis of simple circuits. (4 L) 2. Network theorems (DC): Superposition Theorem, Thevenin’s Theorem, Norton’s Theorem, Maximum Power Transfer Theorem. (5 L) 3. Magnetic circuits: Review of fundamental laws of electromagnetic induction, Self and mutual inductances, Solution of magnetic circuits. (3 L)

	4. Generation of alternating voltage and current, E.M.F. equation, Average and R.M.S. value, Phase and phase difference, Phasor representation of alternating quantity, Behaviour of AC circuits, Resonance in series and parallel R-L-C circuits. (6 L) 5. Poly-phase system, Advantages of 3-phase system, Generation of 3-phase voltages, Voltage, current and power in a star and delta connected systems, 3-phase balanced and unbalanced circuits. (3 L) 6. Semiconductor Devices: Construction, working and V-I characteristics of diode, Zener diode, Zener diode as a voltage regulator, LED. (6 L) 7. Transistors:Introduction to BJT, FET, MOSFET; CMOS, working principle, and V-I characteristics of Transistors, biasing of BJT circuits-fixed bias, emitter bias, feedback bias, voltage divider bias, transistor as an amplifier. (8 L) 8. Operational amplifier:Introduction, applications: inverting, non-inverting amplifier, unity follower, integrator, differentiator, summing circuit.(4 L) 9. Introduction of logic gates, memory: ROM, RAM. (3 L)
Text Books, and/or reference material	**TEXT BOOKS** 1. Electrical & Electronic Technology by Hughes, Pearson Education India. 2. Introduction Electronic Devices & Circuit Theory, 11/e, 2012, Pearson: Boylestad & Nashelsky. 3. Electronics: Fundamentals and Applications By D. Chattopadhyay, P. C. Rakshit; New Age Int. Publication. **REFERENCE BOOKS** 1. Advanced Electrical Technology by H. Cotton, Reem Publication Pvt. Ltd. 2. Electrical Engineering fundamentals by Vincent Deltoro, Pearson Edu. India. 3. The Art of Electronics 3e, by Paul Horowitz, Winfield Hill. 4. Electronics - Circuits and Systems, Fourth Edition by Owen Bishop. 5. Electronics Fundamentals: Circuits, Devices & Applications (8e) by Thomas L. Floyd & David M. Buchla.

Mapping of COs (Course Outcomes) and POs (Programme Outcomes)

Course	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
XEC02	CO1	3	3	3	3	3	1	1	1	1	1	1	1
	CO2	3	3	3	3	2	1	2	1	1	1	1	1
	CO3	3	3	3	3	3	2	2	1	1	1	1	1
	CO4	2	3	2	2	-	1	-	-	-	-	-	1
	CO5	3	2	1	2	2	1	-	-	2	-	-	1
	CO6	3	2	2	2	3	-	-	-	2	-	-	1

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CSS51	**Computer Programming Laboratory**	PCR	0	0	3	3	2
Pre-requisites		Course Assessment methods [Continuous (CT) and end assessment (EA)]					
NIL		CT+EA					
Course Outcomes	**CO1**: To understand the principle of operators, loops and branching statements. **CO2**: Implementation of function, recursion, arrays, and pointers based several						

	types of assignments. **CO3**: To detail out the operations of strings. **CO4**: To understand structure and union. **CO5**: Application of C-programming to solve various types of problems.
Topics Covered	**List of Experiments:** 1. Programs on expression evaluation. 2. Programs on conditional statements and branching 3. Programs on iterations/loops. 4. Applications of Arrays 5. Programs on basics of functions and pointers. 6. Programs on string using array and pointers. 7. Programs on recursion. 8. Programs on structures, union. 9. Programs on File Operations. 10. Case Studies.
Text Books, and/or reference material	**Text Books:** 1. Y. Kanetkar, "Let Us C", BPB Publications, Sixteenth edition, 2017. 2. B. S. Gottfried, "Programming with C", McGraw Hill Education, 4th Ed., 2018. 3. E. Balagurusamy, "Computing Fundamentals and C Programming", McGraw Hill Education; Second edition, 2017. **Reference Books:** 1. P. Dey and M. Ghosh, “Computer fundamentals and programming in C”, Oxford press, 2013. 2. R. Thareja, “Computer fundamentals and programming in C”, Oxford press, 2013. 3. Schaum’s Outline, Programming with C.

Mapping of COs (Course Outcomes) and POs (Programme Outcomes)

Course	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CSS51	CO1	3	3	2	-	-	2	-	-	-	-	-	-
	CO2	2	2	1	-	-	1	-	-	-	-	-	-
	CO3	3	2	2	-	-	1	-	-	-	-	-	-
	CO4	2	3	2	-	-	2	1	-	-	-	-	-
	CO5	3	3	3	-	1	2	1	-	-	-	-	-

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
PHS51	**Engineering Physics Laboratory**	PCR	0	0	2	2	1
Pre-requisites		Course Assessment methods [Continuous evaluation (CE) and end assessment (EA)]					
NIL		CE+EA					
Course Outcomes	**CO1**: To realize and apply different techniques for measuring refractive indices of different materials. **CO2**: To realize different types of waveforms in electrical signals using CRO.						

	CO3: To understand charging and discharging mechanism of a capacitor. **CO4**: To understand interference, diffraction and polarization related optical phenomena. **CO5**: To acquire basic knowledge of light propagation through fibers.
Topics Covered	1. Find the refractive index of a liquid by a travelling microscope. 2. Determine the refractive index of the material of prism using spectrometer. 3. Determination of amplitude and frequency of electrical signals by oscilloscope. 4. To study the characteristics of RC circuits. 5. To study Brewster's law/Malus' law using laser light. 6. To study the diffraction of light by a grating. 7. To study the interference of light by Newton's ring apparatus. 8. To determine numerical aperture of optical fiber. 9. Determination of Planck constant.
Text Books and/or reference material	**SUGGESTED BOOKS**: 1) A Text Book on Practical Physics – K. G. Mazumdar and B. Ghosh 2) Practical Physics – Worsnop and Flint

Mapping of COs (Course Outcomes) and POs (Programme Outcomes)

Course	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
PHS51	CO1	3	2	1	-	-	-	-	-	2	1	-	1
	CO2	3	2	1	-	-	1	-	-	2	1	-	1
	CO3	3	1	-	-	-	-	-	-	2	1	-	1
	CO4	3	2	-	1	-	1	1	-	2	1	-	1
	CO5	3	2	1	-	1	1	1	-	2	1	-	1

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CYS51	**Engineering Chemistry Laboratory**	PCR	0	0	2	2	1
Pre-requisites		Course Assessment methods [Continuous evaluation (CT) and end assessment (EA)]					
NIL		CT+EA					
Course Outcomes	**CO1**: To learn basic analytical techniques useful for engineering applications. **CO2**: Synthesis and characterization methods of few organic, inorganic and polymer compounds of industrial importance. **CO3**: Learn chromatographic separation methods. **CO4**: Applications of spectroscopic measurements.						
Topics Covered	1. Experiments based on pH metry: Determination of dissociation constant of weak acids by pH meter. 2. Experiments based on conductivity measurement: Determination of amount of HCl by conductometric titration with NaOH. 3. Estimation of metal ion: Estimation of Fe^{2+} by permangnomentry 4. Estimation of metal ion: Determ. of total hardness of water by EDTA titration. 5. Synthesis and characterization of inorganic complexes: e. g. $Mn(acac)_3$, $Fe(acac)_3$, *cis*-bis(glycinato)copper(II) monohydrate and their characterization by m. p., FT-IR etc. 6. Synthesis and characterization of organic compounds:						

	e.g.Dibenzylideneacetone. 7. Synthesis of polymer: polymethylmethacrylate 8. Verification of Beer-Lambert's law and determination of amount of iron present in a supplied solution. 9. Chromatography: Separation of two amino acids by paper chromatography 10. Determination of saponification value of fat/ vegetable oil
Text Books and/or reference material	Suggested Text Books: 1. Vogel's Quantitative Chemical Analysis (6th Edition) Prentice Hall 2. Advanced Physical Chemistry Experiments: by Gurtu&Gurtu 3. Comprehensive Practical Organic Chemistry: Preparative and Qualitative Analysis by V. K. Ahluwalia and S. Dhingra Suggested Reference Books: 1. Practical Chemistry by R.C. Bhattacharya 2. Selected experiments in Physical Chemistry by N. G. Mukherjee

Mapping of COs (Course Outcomes) and POs (Programme Outcomes)

Course	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CYS51	CO1	2	1	-	1	-	-	-	-	-	-	-	-
	CO2	-	1	-	1	1	2	-	-	-	-	-	-
	CO3	2	-	-	1	1	-	-	-	-	-	-	-
	CO4	-	1	-	1	1	-	-	-	-	-	-	-

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
XES51	**Engineering Graphics**	PCR	1	0	3	4	2.5
Pre-requisites		Course Assessment methods [Continuous (CT) and end assessment (EA)]					
NIL		CT+EA					
Course Outcomes	**CO1**: Ability of mental visualization of different objects **CO2**: Theoretical knowledge of orthographic projection to solve problems on one/two/three dimensional objects **CO3**: Able to read/interpret industrial drawing and to communicate with relevant people						
Topics Covered	Graphics as language of communication; technical drawing tools and their up-keep; types of lines; construction of geometrical figures; lettering and dimensioning. [6L] Construction and use of scales; construction of curves of engineering importance such as curves of conic section; spirals, cycloids, involutes and different loci of points; use of equations for drawing some curves. [9L] Descriptive geometry: necessity and importance of orthographic projection; horizontal and vertical reference planes; coordinate of points; orthographic projection of points and lines situated in different quadrants, viz. 1st, 2nd, 3rd and 4th quadrants; traces of lines. First angle and third angle projection of lines and planes; views from top, front and left (or right); true length and true inclination of lines with planes of projections; primary auxiliary projection of points, lines and planes; auxiliary plan and auxiliary elevation. [9 L] Projection of simple regular solids, viz. prisms, cubes, cylinders, pyramids, cones, tetrahedrons, spheres, hemi-spheres etc. [6 L]						

	Section of solids; section by perpendicular planes; sectional views; true shapes of sections. [6 L] Dimensional techniques; international and national standards (ISO and BIS). [3 L] Freehand graphics. [3 L]
Text and/or reference material	1)Engineering Drawing and Graphics – K. Venugopal 2)Engineering Drawing – N. D. Bhat 3)Practical Geometry and Engineering Graphics – W. Abbott

Mapping of COs (Course Outcomes) and POs (Programme Outcomes)

Course	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
XES51	CO1	1	-	-	-	-	-	-	-	-	-	-	-
	CO2	1	1	-	-	-	-	-	-	-	-	-	-
	CO3	1	-	1	-	-	-	-	-	-	-	-	-

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
XES52	**Basic Electrical and Electronics Laboratory**	PCR	0	0	3	3	2
Pre-requisites		Course Assessment methods [Continuous (CT) and end assessment (EA)]					
NIL		CT+EA					

Course Outcomes	**CO1**: Learn to analyse the electric circuits using network theorems. **CO2**: Understand the characteristics of fluorescent lamp and compact fluorescent lamp. **CO3**: Analyze the behaviour of single phase and three phase AC circuits. **CO4**: Understand the application of electronics components, diode circuits as rectifier circuits and voltage regulators. **CO5**: Evaluate and study the performance of the transistor as a switch. **CO6**: Create inverting and non-inverting amplifier circuits using Op-Amp.
Labs Conducted.	1. Verification of the network theorems (DC). 2. Study of the characteristics of fluorescent and compact fluorescent lamp. 3. Analysis of the three phase system for star and delta connected load. 4. Study of the series and parallel R-L-C circuit. 5. Identify and understand the use of different electronic and electrical instruments, various electronic components. 6. Study of half-wave and full-wave (bridge) rectifier with and without capacitor filter circuit. Zener diode as a voltage regulator. 7. Study the performance of a transistor as a switch through NOT gate. 8. Realization of Inverting and Non-inverting amplifier using Op-Amp.
Text Books, and/or reference material	**TEXT BOOK** 1. Handbook of Laboratory Experiments in Electronics and Electrical Engineering by A. M. Zungeru , J. M. Chuma, H. U. Ezea. 2. Experiments Manual for use with Electronic Principles (Engineering Technologies and the Trades) by Albert Paul Malvino Dr., David J. Bates, et al. **REFERENCE BOOKS** 1. Laboratory Courses in Electrical Engineering (5th Edition) by S. G. Tarnekar, P. K. Kharbanda, S. B. Bodhke, S. D. Naik, D. J. Dahigaonkar (S. Chand

	Publications). 2. The Art of Electronics 3e, by Paul Horowitz, Winfield Hill. 3. Electronic Principles, by Albert Paul Malvino Dr. and David J. Bate.

Mapping of COs (Course Outcomes) and POs (Programme Outcomes)

Course	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
XES52	CO1	3	3	3	3	3	1	1	1	2	2	2	3
	CO2	3	3	2	3	3	3	1	1	2	2	2	3
	CO3	3	3	2	3	3	2	1	1	2	2	2	3
	CO4	3	3	3	3	3	1	1	1	2	2	2	3
	CO5	3	2	1	2	2	1	-	-	2	-	-	-
	CO6	3	2	2	2	3	-	-	-	2	-	-	-

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CSS52	**Data Structures and Algorithms Laboratory**	PCR	0	0	3	3	2
Pre-requisites		Course Assessment methods [Continuous (CT) and end assessment (EA)]					
NIL		CT+EA					
Course Outcomes	**CO1**: Understanding the suitability and compatibility of array and linked list implementations for different application problems. **CO2**: Understanding the concept of abstract data types from real-life scenarios and their implementation in computing system. **CO3**: Identify, design and implementation of stack, queue, binary tree, and graph as applicable for given problem. **CO4**: Implementation of different searching and sorting techniques using appropriate data structures and perform efficiency analysis. **CO5**: Create efficient algorithms for real-life applications.						
Topics Covered	**List of Experiments:** 1. Application of arrays using dynamic memory allocation. 2. Implementation and Applications of linked lists. 3. Implementation of stack, and applications of stack. 4. Implementation of queue, applications of queue: Priority queue. 5. Implementation of Binary tree, Binary tree traversal: Preorder, Inorder and Postorder traversal. 6. Implementation of binary search tree and operations on it. 7. Implementation of linear search, binary search (recursive, non-recursive). 8. Implementation of different sorting algorithms. 9. Implementation of graph algorithms: Breadth first search, Depth first search. 10. Case Studies.						
Text Books, and/or reference material	**Text Books:** 1. S. Lipschutz, “Data Structures (Schaum’s Outline Series)”, McGraw Hill Education; First edition (2017). 2. E. Horowitz, S. Sahni, S. Anderson-Freed, “Fundamentals of Data Structures in C”, Universities Press; Second edition (2008).						

3. E. Balagurusamy, "Programming in ANSI C", McGraw Hill Education India Private Limited, Seventh edition (2017).

Reference Books:

1. B. S. Gottfried, "Programming with C", McGraw Hill Education, 4thEd. (2018).

Mapping of COs (Course Outcomes) and POs (Programme Outcomes)

Course	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CSS52	CO1	-	1	1	1	-	-	-	-	-	-	-	-
	CO2	-	1	1	3	-	-	-	-	-	-	-	-
	CO3	2	2	3	2	1	-	-	-	-	-	-	-
	CO4	2	2	2	1	1	-	-	-	-	-	-	-
	CO5	3	3	3	3	3	-	1	1	-	-	1	2

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
XXS51	**Extra Academic Activities**	PCR	0	0	2	2	1

Pre-requisites	Course Assessment methods [Continuous (CT) and end assessment (EA)]
NIL	CT+EA

Course Outcomes	**CO1**: Social Interaction through the medium of sports **CO2**: Team building and self defence
Topics Covered	**YOGA** • Introduction of Yoga- Suryanamaskar. (1L) • Sitting Posture / Asanas – Padmasana, Vajrasana, Ardha Kurmasana, Ustrasana, Janusirshasana, Gomukhasana, Bhadrasana. (7L) • Mudra- Gyana Mudra, Chin Mudra.(1L) • Laying Posture/ Asana-Pavana Mukhtasana, Uttana Padasana, Sarpasana, Bhujangasana (Cobra Pose), Eka Pada Salabhasana, Dhanurasana, Chakrasana, Viparitkarani, Ardha Halasana (Half Plough Pose), Naukasana (Boat Posture), Shavasana (Relaxing Pose) , Makarasana. (7L) • Meditation-Om Chant. (1L) • Standing Posture / Asana-Tadasana (Mountain Pose), Vrikshana (Tree Pose), Ardha Chandrasana, Padahastasana, Ardha Chakrasana (Half Wheel Posture). (5L) • Pranayama-Deep Breathing, Anulom Vilom, Shitali, Bhramari.(5L) • Kriya- Kapalbhati. (1L) **TAEKWONDO** • Introduction About Taekwondo- Meaning Of Taekwondo, Korean Language Of Dress, Fighting Area, Punch, Block, Kicks etc. (1L) • Stance- Ready Stance, Walking Stance, Front Stance, Back Stance. (2L) • Punch Technique- Front Fist Punch, Double Fist Punch, With Stance etc. Blocks- Upper Blocks, Middle Block, Side Block, Suto etc. (4L) • Foot Technique- Standing Kick, Front Kick, Doliyo, Back Kick etc. (6L) • Poomsae (Forms)- Jang, Yi Jang. (6L)

	• Self Defense Technique- Self Defense from Arms, Fist and Punch. (4L) • Sparring (Kyorugi)- One Step Sparring. (2L) • Combination Technique- Combined Kick and Punch. (2L) • Project Work (1L)

Mapping of COs (Course Outcomes) and POs (Programme Outcomes)

Course	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
XXS51	CO1	-	-	-	-	-	2	-	-	2	-	-	1
	CO2	-	-	-	-	-	-	-	2	3	-	-	1

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

THIRD SEMESTER

Course Code	Title of the course	Program Core (PCR)/Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
MAC331	**Mathematics-III**	PCR	3	1	0	4	4
Pre-requisites		Course Assessment methods [Continuous (CA), mid-term (MT) and end term assessment (ET)]					
Basic knowledge of topics included in MAC01 & MAC02.		CA+MT+ET					
Course Outcomes	**CO1**: Acquire the idea about mathematical formulations of phenomena in physics and engineering. **CO2**: To understand the common numerical methods to obtain the approximate solutions for the intractable mathematical problems. **CO3**: To understand the basics of complex analysis and its role in modern mathematics and applied contexts. **CO4**: To understand the optimization methods and algorithms developed for solving various types of optimization problems.						
Topics Covered	**Partial Differential Equations (PDE):** Formation of PDEs; Lagrange method for solution of first order quasilinear PDE; Charpit method for first order nonlinear PDE; Homogenous and Nonhomogeneous linear PDE with constant coefficients: Complimentary Function, Particular integral; Classification of second order linear PDE and canonical forms; Initial & Boundary Value Problems involving one dimensional wave equation, one dimensional heat equation and two dimensional Laplace equation. [14 L] **Numerical Methods:** Significant digits, Errors; Difference operators; Newton's Forward, Backward and Lagrange's interpolation formulae; Numerical solutions of nonlinear algebraic/transcendental equations by Bisection and Newton-Raphson methods; Trapezoidal and Simpson's 1/3 rule for numerical integration; Euler's method and modified Eular's methods for solving first order differential equations. [14 L] **Complex Analysis:** Functions of complex variable, Limit, Continuity and Derivative; Analytic function; Harmonic function; Conformal transformation and Bilinear transformation; Complex integration; Cauchy's integral theorem; Cauchy's integral formula; Taylor's theorem, Laurent's theorem (Statement only); Singular points and residues; Cauchy's residue theorem. [17 L] **Optimization:** **Mathematical Preliminaries:** Hyperplanes and Linear Varieties; Convex Sets,						

	Polytopes and Polyhedra. [2 L] **Linear Programming Problem (LPP):** Introduction; Formulation of linear programming problem (LPP); Graphical method for its solution; Standard form of LPP; Basic feasible solutions; Simplex Method for solving LPP. [9 L]
Text Books, and/or reference material	Text Books: 1. An Elementary Course in Partial Differential Equations-T. Amarnath 2. Numerical Methods for scientific & Engineering Computation- M.K.Jain, S.R.K. Iyengar&R.K.Jain. 3. Foundations of Complex Analysis- S. Ponnuswami 4. Operations Research Principles and Practices- Ravindran, Phillips, Solberg 5. Advanced Engineering Mathematics- E. Kreyszig Reference Books: 1. Complex Analysis-L. V. Ahfors 2. Elements of partial differential equations- I. N. Sneddon 3. Operations Research- H. A. Taha

Mapping of COs (Course Outcomes) and POs (Programme Outcomes)

POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	-	-	2	-	2	-	-	2	2	3
CO2	1	2	1	1	-	-	3	-	2	1	-	3
CO3	3	-	-	2	-	1	2	-	2	-	-	3
CO4	3	3	3	2	-	-	1	2	1	-	2	3

Course Code	Title of the course	Program Core (PCR)/Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CYC301	**State of Mater and Chemical Thermodynami-cs**	PCR	3	1	0	4	4

Pre-requisites	Course Assessment methods [Continuous (CA), mid-term (MT) and end assessment (ET)]
NIL	CA+MT+ET

Course Outcomes	**CO1**: To learn the scientific development and rationale of Kinetic Theory of Gas and its usefulness. **CO2**: To understandthe origin of surface tension and viscosity and their application. **CO3**: To understand the crystal structure and principle of X-Ray crystallography. **CO4**: Foundationinchemical thermodynamics. **CO5**:Analyzing effect of various experimental parameters towards equilibrium condition of a chemical reaction/process. **CO6**:Providing the basic knowledge useful for higher level study in the field of statistical and non-equilibrium thermodynamics.

Topics Covered	**Kinetic Theory of Gases and Real gases** a. Kinetic theory of ideal gas, Concept of pressure and temperature; Collision of gas molecules; Collision diameter; Collision number and mean free path; Frequency of binary collisions (similar and different molecules); Rate of effusion. (2 L) b. Nature of distribution of velocities, Maxwell's distribution of speed and kinetic energy; Average velocity, root mean square velocity and most probable velocity; Principle of equipartition of energy and its application to calculate the classical limit of molar heat capacity of gases. (6 L) c. Deviation of gases from ideal behaviour; Compressibility factor; Boyle temperature; Andrew's and Amagat's plots; van der Waals equation and its features; its derivation and application in explaining real gas behaviour; Virial equation of state, Existence of critical state, Critical constants; Law of corresponding states. (6 L) d. Viscosity of gases and effect of temperature and pressure on coefficient of viscosity (qualitative treatment only). (2 L) **Liquids**(4 L) Definition of Surface tension, its dimension and principle of its determination using stalagmometer; Viscosity of a liquid and principle of determination of coefficient of viscosity using Ostwald viscometer; Effect of temperature on surface tension and coefficient of viscosity of a liquid (qualitative treatment only) **Solids**(6 L) Forms of solids, crystal systems, unit cells, Bravis lattice types, Symmetry elements; Law of constancy of interfacial angles, Law of rational indices; Miller indices of different planes and interplanar distance, Bragg's law; Structures of NaCl, KCl and CsCl (qualitative treatment only); Defects in crystals; Glasses and liquid crystals. **Chemical thermodynamics** Basic concepts on the 1st law of thermodynamics: exact and inexact differential, reversible and irreversible processes, heat capacity, different thermodynamic relations for reversible/irreversible isothermal and adiabatic processes. Joule experiment, Internal pressure, Joule-Thomson cooling effect. Thermochemistry and adiabatic flame temperature.(6 L) Second law and its elementary interpretation, Carnot's cycle and theorems, Refrigeration, Concept of entropy, Clausius inequality, Carnot theorem, Gibbs and Helmholtz functions, criteria of spontaneity, Thermodynamic probability, Thermodynamics equation of states; Maxwell equations in thermodynamics, Concept of partial molar quantity, Chemical potential and escaping tendency, Thermodynamics of ideal mixing, Clausius-Clapeyron equation and phase diagram of single component systems. (10 L) **Chemical Equilibrium**(4 L) Conditions of spontaneity and equilibrium, degree of advancement and Le Chatelier principle; Van't Hoff isotherm, isobar and isochore systems. Various factors affecting the equilibrium condition.
Text Books, and/or reference material	1. Physical chemistry by P. Atkins and J.de Paula 2. Physical chemistry by Laidler and Meiser 3. A text book of physical chemistry by K.L.Kapoor (Vol 1 and 2) 4. Physical chemistry by P.C.Rakshit 5. Physical Chemistry by Barrow, G.M. Tata McGraw-Hill (2007)

CURRICULUM AND SYLLABUS FOR INTEGRATED MSC IN CHEMISTRY

Mapping of COs (Course Outcomes) and POs (Programme Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	2	3	1	1	1	3	1	1	1	3
CO2	3	1	2	3	2	1	1	3	2	1	1	3
CO3	3	3	2	3	3	3	1	3	3	1	1	3
CO4	3	1	1	3	2	1	1	3	2	1	1	2
CO5	3	1	1	3	2	1	1	2	2	1	1	2
CO6	3	1	1	1	1	1	1	3	1	1	1	3

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CYC302	**Atomic Structure and Chemical Bonding**	PCR	3	0	0	3	3
Pre-requisites		Course Assessment methods [Continuous (CA), mid-term (MT) and end assessment (ET)]					
NIL		CA+MT+ET					
Course Outcomes	**CO1:** To know the history of development of the subject and understand the basic principle of quantum theory. **CO2:** To be exposed with hydrogen atom and its spectrum, Schrodinger wave equation and quantum numbers, energy, shape and size and orientation of orbitals. **CO3:** To know symmetric and antisymmetric wave function and concept of spin **CO4:** To learn shape of molecules, electron count and VSEPR theory. **CO5:** To know quantum mechanical treatment of VBT and MOT. **CO6:** To understand the concept of hybridisation of atomic orbital and molecular properties.						
Topics Covered	Genesis: Planks quantisation of energy, photoelectric effect, Compton effect, De Broglie wave particle duality, Heisenberg uncertainty principle, wave function, Born interpretation. [4 L] Schrödinger wave equation of hydrogen atom, separation of variables, quantum numbers, Principal quantum number, orbital quantum numbers, magnetic quantum numbers, shape and size of orbital, uncertainty principal and quantisation of space. [5 L] Electron probability density, radial part, radial distribution curve and its interpretation, node and angular part of wave s (imaginary and real form) and orbitals shape, electron cloud density representation of hydrogen orbitals. [5 L] Electron in magnetic field, Zeeman effect, spectrum of hydrogen atom and electron spin. [3 L] Many electron atoms and ions: Antisymmetric principle, Pauli's exclusion principle, Hund's rule,exchange energy, Aufbau principle. [3 L]						

	Covalent bond:[3 L] Covalence bond: Lewis structure and octet rule, violation of octet rule. [1 L] Variation principle, one electron wave function, valence bond theory with H_2 [2 L] Hybridisation, sigma bond, pi bond, delta bond, bond distance, bond energies, bond angle. [5 L] Directional property, shape, VSEPR. [2 L] Bond moment and dipole moments, hydrogen bond, inter molecular forces. [2 L] Molecular orbital theory, H_2^+, binuclear(AB) [5 L]
Text Books, and/or reference material	1. Inorganic Chemistry, Part I, R. L. Dutta New Book Stall 2. Fundamental concept of Inorganic Chemistry, vol I and II, Asim K. Das, CBS publishers & distributors 3. Inorganic Chemistry, Huheey, Keiter, Keiter, Medhi, Pearson education 4. Inorganic chemistry, Shriver & Atkins, Oxford 5. Concept and models of inorganic Chemistry, Douglas, Mcdeniel, Alexander, Wiley India Pvt. Ltd.

Mapping of COs (Course Outcomes) and POs (Programme Outcomes)

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	3	3	1	1	1	2	1	2	2	1
CO2	3	2	3	3	--	1	1	2	1	2	2	1
CO3	3	2	3	3	--	1	--	2	1	2	2	1
CO4	3	2	3	3	--	1	1	2	1	2	2	1
CO5	3	2	3	3	--	1	1	2	1	2	2	1
CO6	3	2	3	3	--	1	1	2	1	1	2	1

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CYC 303	**Stereochemistry and Basic Principle of Organic Chemistry**	PCR	3	0	0	0	0
Pre-requisites		Course Assessment methods [Continuous (CA), mid-term (MT) and end assessment (ET)]					
NIL		CA+MT+ET					
Course Outcomes	**CO1**: To Learn basic concept of stereochemistry **CO2**: To Learn molecular symmetry, designation of chiral centre, axis and helices **CO3**: To Learn selectivity issues in organic reactions **CO4**: To Learn conformational analysis **CO5**: To Learn stereo-electronic effects on stability and rate of reactions						

Topics Covered	Basic concept of stereochemistry: Isomerism; asymmetric and dissymmetric centres /molecules, Conformation and configurational nomenclature. [8 L] Molecular symmetry: chirality, chiral axis, helicity. [8 L] Regio-, chemo- and stereoselective reactions. [8 L] Conformational analysis of acyclic and cyclic compounds. [6 L] Stereo-electronic effects:Electronic effects on stability and rate of organic reactions: inductive, electromeric, mesomeric, hyperconjugative effects, concepts of resonance. Steric effects: steric acceleration, steric retardation, steric inhibition of resonance. [10 L]
Text Books, and/or reference material	1. Basic stereochemistry of organic molecules: S. Sengupta 2. Stereochemistry: Conformation and Mechanism; P.S. Kalsi 3. Organic Chemistry: Morrison and Boyd 4. Organic stereochemistry: D. Nasipuri 5. Stereochemistry of Carbon Compounds: Ernest L. Eliel. 6. Organic Chemistry: Sachin Kumar Ghosh

Mapping of COs (Course Outcomes) and POs (Programme Outcomes)

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	3	3	1	2	2	3	3	1	3	2
CO2	3	3	3	3	1	2	3	3	3	1	3	2
CO3	3	3	3	3	3	3	2	3	3	3	3	3
CO4	3	3	3	3	2	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3	3	3

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CYS351	**Qualitative Analysis of Organic Samples**	PCR	0	0	3	3	2
Pre-requisites		Course Assessment methods					
NIL		Continuous assessment (CA)+ end assessment (EA)					
Course Outcomes	**CO1**: A basic idea about the physical methods like; M.P., B.P., distillation and crystallization for analysis of organic compounds. **CO2**: An idea about the uses of reagents and solvents for analysis of organic compounds **CO3**: Detection and identification of special elements and functional groups of organic samples. **CO4**: Learn about the uses of proper solvent for purification of organic compounds. **CO5**: Learn about minimum use of sample for analyses.						

Topics Covered	**MixedMelting Point Determination:** Urea – Cinnamic acid mixture of various compositions (1:4, 1:1, 4:1) **Distillation**: Simple distillation of ethanol-water mixture using water condenser Distillation of nitrobenzene and aniline using air condenser Purification of common organic solvents by distillation; methanol, petroleum ether, THF, chloroform etc. **Crystallization**: Concept of induced crystallization, Phthalic acid from hot water (using fluted filter paper and stem less funnel), Acetanilide from boiling water, Naphthalene from ethanol, Benzoic acid from water. **Decolourization and Crystallization:** Decolourization of brown sugar (sucrose) with animal charcoal using gravity filtration. Crystallization and decolourization of impure naphthalene (100 g of naphthalene mixed with 0.3 g of Congo red using 1 g decolourizing carbon) from ethanol. **Sublimation (Simple and vacuum**): Camphor, Naphthalene, phthalic acid and Succinic acid. **Identification of some common organic molecules:** Methanol, ethanol, acetone, glycerol, aniline, nitrobenzene, benzyl alcohol, formic acid, acetic acid, succinic acid, tartaric acid, salicylic acid, glucose, sucrose, resorcinol. **Identification of unknown organic compound:** Identification of an organic compound through the functional group analysis, determination of melting point and preparation of suitable derivatives.
Text Books, and/or reference material	(i) Textbook of Practical Organic Chemistry by Vogel (ii) Advanced practical chemistry by S. C. Das (iii) An Advanced Course in Practical Chemistry by A. K. Nad, B. Mahapatra & A. Ghoshal

Mapping of COs (Course Outcomes) and POs (Programme Outcomes)

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	2	3	2	2	3	3	2	3	2
CO2	2	3	3	3	2	2	3	2	3	3	2	2
CO3	3	3	3	2	1	3	2	3	2	2	1	2
CO4	2	2	1	3	2	2	3	2	1	2	3	2
CO5	3	2	2	1	3	2	2	3	2	1	2	3

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
PHC334	**Physics II**	PCR	3	0	0	3	3

Pre-requisites	Course Assessment methods [Continuous (CA), mid-term (MT) and end assessment (ET)]
NIL	CA+MT+ET

Course Outcomes	**CO1**: Able to understand the principles of classical mechanics apply to solve classical problems related to solving Lagrange's and Hamilton's equations of motion. **CO2**: Able to apply fundamental knowledge of different co-ordinate systems to

	describe the spatial variations of the physical quantities dealt in electromagnetic field theory. **CO3**: Able to explain fundamental laws governing electromagnetic fields and evaluate the physical quantities of electromagnetic fields (Field intensity, Flux density etc.). **CO4**: Gain an integrative overview of electromagnetic waves, its propagation in different media and different phenomena related to electromagnetic wave propagation.
Topics Covered	**Classical Mechanics**: D'Alembert's principle, Lagrange's equation of motion, Some applications of Lagrange's equation of motion, Hamilton's equation of motion, Some applications of Hamilton's equation of motion and its physical significance. [6L] **Vector Analysis**: Vector field, Divergence and curl of a vector field and their physical significance, Gauss's divergence theorem, Stoke's theorem, Green's theorem, Different coordinate systems (Cartesian, spherical and cylindrical). [8L] **Electrostatics**: Divergence of electrostatic field, Gauss's Law of electrostatics and its applications, Laplace's equation, Poisson's equation, Continuity equation, Capacitor. [6L] **Magnetostatics**: Curl of magnetic field, Ampere's Circuital law and its applications, Curl of electric field and divergence of magnetic field, Concepts of scalar and vector potentials. [7L] **Electromagnetic Induction and Maxwell's Equation:** Faraday's law of electromagnetic induction, Concept of displacement current, Maxwell's equation in free space, Poynting Theorem. Some examples. [7L] **Alternating Current**: L-R, C-R, L-C-R series and parallel circuits, Q- factor, Resonance, Maximum power transfer theorem, Voltage magnification factor, Band width of circuit. [8L]
Text Books, and/or reference material	**TEXT BOOK**: 1. Vector Analysis: Murray Spiegel (Author),Seymour Lipschutz, Dennis Spellman 2. Introduction to Electrodynamics: David J. Griffith 3. Introduction to Classical Mechanics: R. G. Takwale & P. S. Puranik **REFERENCE BOOKS**: 1.Classical Mechanics: N. C. Rana & P. S. Joag 2.Classical Mechanics: H. Goldstein 3. Electricity and Magnetism: D. Chattopadhyay & P. C. Rakshit

Mapping of COs (Course Outcomes) and POs (Programme Outcomes)

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	2	-	1	1	-	1	1	-	1
CO2	3	2	-	1	1	-	-	-	2	1	-	1
CO3	3	2	1	1	-	1	-	-	1	1	-	1
CO4	3	2	1	1	-	1	1	-	2	1	-	1

CURRICULUM AND SYLLABUS FOR INTEGRATED MSC IN CHEMISTRY

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture(L)	Tutorial (T)	Practical (P)	Total Hours	
PHS 384	**Physics II Laboratory**	PCR	0	0	3	3	2

Pre-requisites	Course Assessment methods: [Continuous evaluation (CE) and end assessment (EA)]
PHS51	CE+EA

Course Outcomes	**CO1**: To realize and apply different techniques for measuring resonance, Q-factor of series L-C-R circuit. **CO2**: To determine the Self-Inductance, Mutual Inductance and verification of Faraday's law. **CO3**: To determine the thermoelectric power of a given thermocouple. **CO4**: To apply the concepts to measure the horizontal component of the earth's magnetic field using a vibrational and deflection magnetometer **CO5**: To calculate the loss of a magnetic specimen by B-H loop measurement.
Topics Covered	1. Study of series L-C-R Resonant Circuit: (i) To draw the resonance curve (ii) To determine the Q- Factor of the circuit (iii) To study the variation of impedance with frequency (iv) verification of maximum power transfer theorem. 2. Verification of Faraday's law. 3. To determine the Mutual-Inductance (M-I) of two coils. 4. Determination of Self-Inductance of a coil. 5. To verify Fresnel's equation for reflection of electromagnetic waves. 6. Draw the (Thermo EMF) – Temperature curve of given thermocouple and hence find thermoelectric power at a given temperature. 7. Determination of horizontal component of the earth's magnetic field using a vibrational and deflection magnetometer. 8. To draw the B-H loop of a given specimen.
Text Books, and/or reference material	**SUGGESTED BOOKS**: 1) A Text Book on Practical Physics – K. G. Majumdar and B. Ghosh 2) Practical Physics – Worsnop and Flint

Mapping of COs (Course Outcomes) and POs (Programme Outcomes)

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	-	2	1	1	2	3	2	1	1
CO2	3	2	1	-	2	1	1	2	3	2	1	1
CO3	3	2	1	1	2	1	1	2	3	2	1	1
CO4	3	2	1	-	2	1	1	2	3	2	1	1
CO5	3	2	1	1	1	1	1	1	2	1	1	1

CURRICULUM AND SYLLABUS FOR INTEGRATED MSC IN CHEMISTRY

FOURTH SEMESTER

<table>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Title of the course</td><td rowspan="2">Program Core (PCR) / Electives (PEL)</td><td colspan="4">Total Number of contact hours</td><td rowspan="2">Credit</td></tr>
<tr><td>Lecture (L)</td><td>Tutorial (T)</td><td>Practical (P)</td><td>Total Hours</td></tr>
<tr><td>CYC401</td><td>Biochemistry: Structure and Function</td><td>PCR</td><td>3</td><td>0</td><td>0</td><td>3</td><td>3</td></tr>
<tr><td colspan="3">Pre-requisites</td><td colspan="5">Course Assessment methods [Continuous (CA), mid-term (MT) and end term (ET)]</td></tr>
<tr><td colspan="3">NIL</td><td colspan="5">CA+MT+ET</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">CO1: To understand the chemistry behind biological processes
CO2: To develop the basic knowledge of cell structure and function
CO3: To learn different chemical aspects of biomolecules such as carbohydrates, lipids, proteins, nucleic acids
CO4: To generate concepts on molecular mechanics amongst biomolecules as a stepping-stone towards biophysical chemistry.</td></tr>
<tr><td>Topics Covered</td><td colspan="7">Amino Acids and Protein Chemistry [10 L]
Introduction, classification according to their composition. Different methods of peptide synthesis. Different methods to determine the composition of peptides and proteins (amino acid analysis). Primary and secondary structure of proteins. Denaturation of proteins. Different methods of molecular weight determination.

Chemistry of mono-, di-, oligo- and poly-saccharides[6 L]
Introduction, Conformation of monosaccharides, structure and functions of important monosaccharides like glycosides, deoxy sugars, myoinositol amino sugars. N-acetylmuramic acid, sialic acid, disaccharides and polysaccharides. Structural polysaccharides – cellulose and chitin. Storage polysaccharides - starch and glycogen.

Lipid chemistry[5 L]
Introduction, Fatty acids, essential fatty acids, structure and function of triacylglycerols, glycerophospholipids, sphingolipids, cholesterol,
Properties of lipid aggregates – micelles, bilayers, liposomes and their possible biological functions. Biological membrane. Fluid mosaic model of membrane structure, Iodine number.

Structure and function of DNA and RNA, nucleosides, nucleotides[12 L]
Introduction, Purine and pyrimidine bases of nucleic acids, base pairing via H-bonding. Structure of RNA and DNA, double helix model of DNA and forces responsible for holding it. Chemical and enzymatic hydrolysis of nucleic acids. The chemical basis of heredity, an overview of replication of DNA, transcription, translation and genetic code. [12 L]</td></tr>
<tr><td>Text Books, and/or reference material</td><td colspan="7">1. Principles of Biochemistry by Lehninger
2. Biochemistry byVoet&Voet.
3. Principles of Physical Biochemistry by K. E. van Holde, C. Johnson and P. S. Ho (Pearson).</td></tr>
</table>

CURRICULUM AND SYLLABUS FOR INTEGRATED MSC IN CHEMISTRY

Mapping of COs (Course Outcomes) and POs (Programme Outcomes)

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	3	3	1	2	2	3	3	1	3	2
CO2	3	3	3	3	1	2	3	3	3	1	3	2
CO3	3	3	3	3	3	3	2	3	3	3	3	2
CO4	3	3	3	3	1	1	2	3	3	1	3	2

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CYC402	**Phase-equilibrium andChemical Kinetics**	PCR	3	1	0	4	4
Pre-requisites		Course Assessment methods [Continuous (CA), mid-term (MT) and end term (ET)]					
NIL		CA+MT+ET					
Course Outcomes	**CO1**:Concept of phase rule and phase diagram of one component system. **CO2**: To learn the colligative properties and their thermodynamic origin and application. **CO3**: To learn the principle and application of distillation techniques of multicomponent systems **CO4**:Understandthefundamentals of chemical kinetics and corresponding theoretical treatment. **CO5**: Concept of catalysts towards reaction rate and its applications. **CO6**: Numerical analysis of the effect of various parameters on reaction kinetics						
Topics Covered	**Phase rule and phase diagram:** Gibb's Phase rule and its derivation; Application of phase rule. Order of Phase transition (1^{st} and 2^{nd} order). Phase diagram: concept of triple point, critical point, supercritical fluid. Transition between paramagnetic and ferromagnetic phases. (4L) **Colligative properties:** Raoult's law and Henrys law; Thermodynamics derivation of colligative properties: relative lowering of vapour pressure, lowering of freezing point, elevation of boiling point, principle and industrial application of Osmosis and Reverse Osmosis, van't Hoff 'i' factor and abnormal behavior of electrolytic solutions, Determination of number average molar mass of macro-molecules.(8L) **Two component systems:** Ideal binary solution, liquid-vapour equilibrium, Lever Rule, Isothermal fractional distillation, Boiling point vs Composition diagrams, Industrial process of isobaric fractional distillation, steam distillation, Vacuum distillation in petroleum refining. Duhem-Margules equation and Konowaloff's rule(derivation not required), Non-ideal binary solution, Deviation from Roult's and Henry's law, Azotropes and industrial methods of Azeotropic distillation: Entrainerand Pressure swing distillation; Nernst distribution law: its derivation and applications. Liquid-Liquid phase equilibrium: phenol-water system, nicotine-water system, effect of pressure, impurities etc on MST, UCST,with examples. (10 L)						

	Chemical Kinetics: Method to monitor the rate of different first and second order reactions. (3L) Rate process approach towards complex reactions including Opposing reaction, parallel reaction, consecutive reactions, chain reactions; Pseudo first order reactions; Determination of order of a reaction. (7 L) Temperature dependence of rate constant; Arrhenius equation, energy of activation Lindemann theory of unimolecular reaction. (2L) Collision theory; Transition State theory, Eyring equation, Interrelations between Arrhenius theory, collision theory and TST. (4 L) Effect of ionic strength (primary and secondary salt effect), dielectric constant and pressure on rate. Primary kinetic isotope effect on the rate. (3L) Kinetics of different composite reactions, including Auto-catalytic and Oscillating reactions. Chemical kinetics of atmospheric reactions. (3L) **Catalysis:**(3L) Rate expressions for Homogeneous catalytic reactions: Acid-base catalyzed reaction, and enzyme catalyzed reactions. Determination of turnover number of enzyme.
Text Books, and/or reference material	1. Physical chemistry by P. Atkins and J.de Paula 2. Physical chemistry by Laidler and Meiser 3. A text book of physical chemistry by K.L. Kapoor 4. Physical chemistry by P.C.Rakshit 5. Physical Chemistry by Barrow, G.M. Tata McGraw-Hill (2007) 6. Physical Chemistry by Castellan, G.W. 4th Ed. Narosa (2004) 7. Chemical kinetics by K.J. Laidler

Mapping of COs (Course outcomes) and POs (Programme Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	2	3	1	1	1	2	3	1	1	2
CO2	3	1	3	3	1	2	1	3	3	1	1	2
CO3	3	1	3	3	1	2	1	3	3	1	1	2
CO4	3	1	1	3	2	1	1	3	2	1	1	2
CO5	3	1	1	3	2	1	1	3	2	1	1	2
CO6	3	1	1	3	2	1	1	2	2	1	1	2

CURRICULUM AND SYLLABUS FOR INTEGRATED MSC IN CHEMISTRY

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CYC403	**Chemistry of Elements and Radioactivity**	PCR	3	1	0	4	4

Pre-requisites	Course Assessment methods [Continuous (CA), mid-term (MT) and end term (ET)]
NIL	CA+MT+ET

Course Outcomes	**CO1**: Knowledge of periodic properties and their variation in period and group. **CO2**: General trends of elements and their compounds for s, p, d and f block elements. **CO3**: Knowledge the structure and function of s, p, d and f block elements. **CO4**: Concept of radioactive nuclei and their properties **CO5**: Measurement of radioactivity **CO6**: Various uses of radioactive elements
Topics Covered	**Periodic property:**Ionisation enthalpy, electronegativity, electron gain enthalpy, atomic radius, ionic radius van der waals radii etc. and their variation in period and group. (5 L) **s block element:**General trends of elements and their compounds: Hydrides, oxides halides and other salts. (2 L) **p block elements:**General trends of elements and their compounds: Hydrides, oxides, oxyacids halides and other important compounds Structure and bonding of boranes,carboranes, silicones, silicates, boron nitride, borazines and phosphazenes, allotropes of carbon phosphorous, sulphur, carbides, nitrides, pseudo-halogens, and interhalogen compounds, chemistry of noble gases.(10 L) **d block and f block elements and their compounds**: General characteristics of elements, size, oxidation states and their stabilisation, hydride, oxides and hydroxides, halides etc. (5 L) **Radioactivity:** Discovery of Radioelement, Nature of radiations, Characteristics of Alpha, Beta, Gamma rays and positrons. (2 L) Nuclear versus chemical reactions, Radioactive decay and recovery, Theory of radioactive disintegration, Cause of Radioactivity, Disintegration series and group displacement law.(3 L) Measurements of radioactivity, Rate of radioactive decay, Determination of decay constant and half-life, Determination of average life, Radioactive equilibrium, numerical problems. (4 L) Artificial transmutation, cyclotron, Artificial radioactivity, Man-made element, Syntheses of Actinide elements. (2 L) Isotopes, isobars, isobaric isotopes and isotones, Methods of isotope preparations: Diffusion method, Thermal diffusion method, Evaporation and distillation method, electrolytic method, Szilard-Chalmers method.(3 L) Uses of isotope: Medicinal uses, uses in analytical chemistry (activation analysis, isotope dilution analysis), Uses to study reaction mechanism, uses to age determination, Agricultural uses, Numerical problems. (3 L) Nuclear Fission, Nuclear fusion, nuclear spallation, Nuclear binding energy and packing fraction, Nuclear binding forces, Nuclear shell model: Magic number.(3L)

Text Books, and/or reference material	1) Inorganic Chemistry, Part I/II, R.L. Dutta, New Book Stall 2) Inorganic chemistry, Shriver & Atkins, Oxford 3) Concise inorganic chemistry, Lee, Wiley India Pvt. Ltd. 4) Advanced Inorganic Chemistry, Cotton & Wilkinson, John Wiley 5) Essentials of Nuclear Chemistry, H. J. Arnikar, New Age International Publishers, 2009

Mapping of COs (Course Outcomes) and POs (Programme Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	3	3	2	2	2	3	3	2	1	1
CO2	2	2	3	2	2	2	2	3	3	1	1	1
CO3	2	3	3	2	2	2	2	3	3	3	1	1
CO4	2	2	3	2	2	2	2	3	3	2	1	1
CO5	3	2	3	2	2	2	2	3	3	3	1	1
CO6	3	2	3	2	2	2	2	3	3	3	1	1

Course code	Title of the course	Program Core (PCR)/Electives (PEL)	Total number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total hours	
CYC404	**Organic Reaction Mechanism and Reactive Intermediates**	PCR	3	1	0	4	4
Pre-requisites		Course Assessment methods [Continuous (CA), mid-term (MT) and end term (ET)]					
NIL		CA+MT+ET					
Course outcomes	**CO1**: To understand structure and reactivities of reactive organic intermediates **CO2**: To understand the fundamentals of electrophilic and nucleophilic substitution reactions **CO3**: To understand various aspects of elimination reactions **CO4**: To understand various aspects of addition reactions to carbon-carbon and carbon-heteroatom multiple bonds **CO5**: To understand methods of investigating the organic reaction mechanism and to apply them in analysing reaction paths. **CO6**: To apply some molecular rearrangement reactions in organic synthesis						
Topics covered	**Chemistry of reactive intermediates:** Formation, structure, stability, detection and reactions of carbocations, radicals, carbenes, nitrenes, carbaions, arynes. (8 L) **Methods for investigation of mechanism:** Factors affecting the rate of reactions, activation energy, transition state, reactiveintermediates, rate determining step, Hammond's postulate, product analysis,detection, isolation and trapping of intermediates, application of isotopes—isotopelabelling, primary kinetic isotope effect, secondary kinetic isotope effect, cross overexperiment. (4 L) **Reaction mechanism of electrophilic and nucleophilic substitution:** Substitution on sp^3 system, Electrophilic attack on benzene, π- and σ-complexes, electronic effect of substituents, *ortho*/*para* ratio, partial rate factors and selectivity, kinetic and thermodynamic control, nitration, halogenations, sulphonation, alkylation					

	and acylation, diazo coupling, *ipso* substitution, Nucleophilic attack on benzene system: substitution of hydrogen and atoms other than hydrogen, reactions *via* aryne intermediate, reactions and reactivity pattern in condensed aromatic systems. (8 L) **Elimination reactions:** E1, E2, and E1CB mechanism, effect of stereochemistry, regioselectivity, isotope and stereo electronic effects effect. (4 L) **Addition to carbon-carbon multiple bonds:** Mechanistic and stereochemical aspects of addition reactions involving electrophiles, nucleophiles and free radicals, regio- and chemoselectivity, Hydrogenation of double, triple bonds and aromatic rings. Hydroboration reaction, Epoxidation reaction. (5 L) **Addition to carbon-heteroatom multiple bonds:** Mechanism of metal hydride reaction of substituted and unsubstituted carbonyl compounds, acids, esters and nitriles. Addition of Grignard reagents, organo-Zn and organo-Li and organo-Si reagents to saturated and unsaturated carbonyl compounds. Wittig reaction. Mechanism of condensation involving enolates. (5 Lectures) **Reaction mechanism of some rearrangement reactions:** Allylic rearrangement, neopentyl rearrangement, pinacol-pinacolone, Beckmann, Wolff, Hofmann, Curtius, Lossen and Schmidt rearrangement, Benzyl-Benzilic acid rearrangement, Bayer-Villiger oxidation. (6 L) **Methods for investigation of mechanism:** Factors affecting the rate of reactions, activation energy, transition state, reactive intermediates, rate determining step, Hammond's postulate, product analysis, detection, isolation and trapping of intermediates, application of isotopes—isotope labelling, primary kinetic isotope effect, secondary kinetic isotope effect, cross over experiment. (4 L)
Text Books, and/or reference materials	1. A Guidebook to Mechanism in Organic Chemistry: Peter Sykes 2. Organic Chemistry: Subrata Sengupta 3. Advanced General Organic Chemistry: A Molecular Approach: Sachin Kumar Ghosh 4. Organic Chemistry: G. Marc Loudon 5. March's Advanced Organic Chemistry: Reactions, Mechanisms, and Structure: Michael B. smith

Mapping of COs (Course Outcomes) and POs (Programme Outcomes)

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	3	2	1	1	3	2	1	3	3
CO2	3	3	2	3	2	1	1	3	2	1	3	3
CO3	3	3	2	3	2	1	1	3	2	1	3	3
CO4	3	3	2	3	2	1	1	3	2	2	3	3
CO5	3	3	3	3	2	3	1	3	2	1	3	3
CO6	3	3	2	3	2	1	1	3	2	1	3	3

CURRICULUM AND SYLLABUS FOR INTEGRATED MSC IN CHEMISTRY

Course code	Title of the course	Program Core (PCR)/Electives (PEL)	**Total number of contact hours**				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total hours	
CYS451	**Thermodynamic Properties of Solution and Mixture Laboratory**	PCR (Practical)	0	0	4	4	2

Pre-requisites	Course Assessment methods: [Continuous evaluation (CE) and end assessment (EA)]
NIL	CE+EA

Course Outcomes	**CO1**:Characterization of thermodynamic parameters. **CO2**:Evaluation of fundamental properties of liquids. **CO3**:Interpreting molecular interaction. **CO4**:developmentoflaboratoryskill,datahandlingandinterpretation,erroranalysis.
Topics Covered	1. Determination of partition coefficient of a solute between an organic solvent and water 2. Determination of equilibrium constant of a reaction $KI+I_2 \leftrightarrow KI_3$ 3. Determination of CST of phenol-water system 4. Determination of heat of solution of Benzoic acid 5. Experiment on viscosity measurement 6. Experiment on surface tension measurement 7. Determination of solubility product of PbI_2 8. Determination of specific rotation of cane sugar 9. Any other practical as assigned by the Instructor
Text Books, and/or reference materials	1. Instruction manual provided by the Instructor 2. Selected experiments in Physical Chemistry By N.G.Mukherjee 3. Advanced Physical Chemistry Experiments: By Gurtu & Gurtu

Mapping of COs (Course Outcomes) and POs (Programme Outcomes)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	1	1	3	1	1	-	2	1	1	2	1
CO2	3	1	1	3	1	1	-	2	1	1	2	1
CO3	3	1	1	3	1	1	-	2	1	1	3	1
CO4	1	1	1	3	1	1	-	2	2	1	2	1

CURRICULUM AND SYLLABUS FOR INTEGRATED MSC IN CHEMISTRY

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CYS452	**Identification of Acidic and Basic Radicals Laboratory**	PCR (Practical)	0	0	4	4	2

Pre-requisites	Course Assessment methods: [Continuous evaluation (CE) and end assessment (EA)]
NIL	CE+EA

Course Outcomes	**CO1**: Knowledge of elementary physical properties of cations and anions **CO2**. Knowledge of dry reactions of cations and anions **CO3**: Knowledge of different wet chemical reactions of cations and anions. **CO4**: Reactions of interfering radicals and their removal process **CO5**: Group separation of cations.
Topics Covered	Qualitative inorganic analysis of mixtures Cation Radicals: Na^{+}, K^{+}, Ca^{+2}, Sr^{+2}, Ba^{+2}, Al^{+3}, Cr^{+3}, Mn^{+2}, Fe^{+3}, Co^{+3}, Ni^{+3}, Cu^{+2}, Zn^{+2}. Anion Radicals: F^{-}, Cl^{-}, Br^{-}, BrO_3^{-}, I^{-}, SCN^{-}, S^{2-}, SO_4^{2-}, $S_2O_3^{2-}$, NO_3^{-}, NO_2^{-}, PO_4^{3-}, BO_3^{3-},CrO_4^{2-}/ $Cr_2O_7^{2-}$, $[Fe(CN)_6]^{4-}$, $[Fe(CN)_6]^{3-}$. Insoluble Materials: Al_2O_3, Fe_2O_3, Cr_2O_3, SnO_2, $SrSO_4$, $BaSO_4$.
Text Books, and/or reference material	1. Text book of qualitative inorganic analysis by A.I. Vogel 2. Practical Inorganic Chemistry by A.K.De and A.K. Sen

Mapping of COs (Course Outcomes) and POs (Programme Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	3	3	3	2	2	1	3	3	3	1	1
CO2	2	2	3	3	2	1	1	3	3	3	1	1
CO3	1	3	3	3	2	2	1	3	3	3	1	1
CO4	3	3	3	3	2	2	1	3	3	3	1	1
CO5	3	2	3	3	2	3	1	3	3	3	1	1

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CYS453	**Biochemistry Laboratory**	PCR (Practical)	0	0	3	3	2

Pre-requisites	Course Assessment methods: [Continuous evaluation (CE) and end assessment (EA)]
NIL	CE+EA

Course Outcomes	**CO1**: Development oflaboratoryskill,datahandlingandinterpretation,erroranalysis **CO2**: Characterization of biomolecules such as proteins, vitamin based on biophysical means **CO3**: Estimation of amino acid, vitamin from unknown sample **CO4**: Dealing and extraction of natural products
Topics Covered	1. Estimation of protein 2. Estimation of carbohydrate 3. Estimation of iodine value of a given oil/fat 4. Estimation of ascorbic acid in fruit juice 5. Separation of a mixture of amino acid 6. Extraction of natural product
Text Books, and/or reference material	1. Instruction manual provided by the Instructor 2. Vogel's Textbook of Practical Organic Chemistry 3. An Advanced Course in Practical Chemistry by A. K. Nad, B. Mahapatra & A. Ghoshal

Mapping of COs (Course Outcomes) and POs (Programme Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	3	3	1	1	-	2	2	1	2	1
CO2	3	2	3	3	1	2	-	2	3	1	2	1
CO3	3	1	3	3	1	1	-	2	3	1	3	1
CO4	1	1	2	3	1	1	-	2	2	1	2	1

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CYE411	**Analytical and Environmental Chemistry**	PEL	3	0	0	3	3
Pre-requisites		Course Assessment methods [Continuous (CA), mid-term (MT) and end term (ET)]					
NIL		CA+MT+ET					

Course Outcomes	**CO1**: Knowledge on chemical processes that regulate the environment as well as attention will be paid to understanding chemical equilibrium and kinetics of natural systems. **CO2**: The course is designed to give the students a broad understanding of the issues related to the basic concepts and principle of different analytical techniques. **CO3**: This course imparting the knowledge about the theory and techniques of analysis including introductory instrumental methods and its fundamental principle. **CO4**: Knowledge on quantification of various environmental parameters. **CO5**: Knowledge on Ecologically safe alternatives and basic principle of green chemistry.
Topics Covered	**Analytical chemistry**: Quantitative and qualitative analysis: Detection of element, detection of cations and anions, Volumetric analysis (acid-base, redox, complexometric), Colorimetric analysis, Titrimetric analysis, gravimetric analysis,

	conductometric, potentiometric titration, ion selective electrodes etc.(18 L) **Environmental chemistry:** Chemical aspects of air, water and soil pollution, chemistry of photochemical and sulphurous smog, stratosphere-chemistry and pollution, chemical specification, priority and water pollutants-their effects, chemical analysis and control. Environmental significance of Radioactive and Biomedical waste disposal. Ecological balance and planning of Industrial complexes. Advanced Oxidation Process, basic principle of. Green chemistry. (18 L)
Text Books, and/or reference material	1. Skoog and West's, Fundamentals of Analytical Chemistry, Cengage Learning India Pvt. Ltd., Delhi 2. Sawyer, C.N., McCarty, P.L., and Parkin, G.F., Chemistry for Environmental Engineering, 5th Edition, McGraw-Hill, Inc., New York. 3. Manahan, S.E., Fundamentals of Environmental Chemistry, Lewis Publishers, Inc., Boca Raton. 4. Seinfeld, J. H. and Pandis, S N., Atmospheric Chemistry and Physics: from Air Pollution to Climate Change, John Wiley. 5. Weber, W. J. Jr., Physicochemical Processes for Water Quality Control, John Wiley and Sons Inc., New York. 6. A. K. Dey, *Environmental Chemistry*, Wiley Eastern, 2002. 7. A. S. Douglas, F. J Holler, S. R. Crouch, Principles of Instrumental Analysis, Thomson, 2007. 8. Metcalf&Eddy, Wastewater Engineering-Treatment and Reuse., 4th edition, McGraw-Hill, 2003; Publisher: McGraw-Hill Science/Engineering/MathISBN-13: 978-0070418783, ISBN-10: 0070418780

Mapping of COs (Course Outcomes) and POs (Programme Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	3	3	2	2	2	3	3	2	1	1
CO2	2	2	3	2	2	2	2	3	3	1	1	1
CO3	2	3	3	2	2	2	2	3	3	3	1	1
CO4	3	3	3	1	2	2	3	3	3	3	1	1
CO5	3	3	3	1	1	3	3	3	3	2	1	1

Course Code	Title of the course	Program Core (PCR)/ Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CYE412	**Chromatographic Separation and Instrumental Methods of Analysis**	PEL	3	0	0	3	3

Pre-requisites	Course Assessment methods [Continuous (CA), mid-term (MT) and end term (ET)]
NIL	CA+MT+ET

Course Outcomes	**CO1**: Get a comprehensive knowledge about solvent extraction, ion exchange and different chromatographic techniques **CO2**: Application of these techniques in research and industrial capacity **CO3**: Working principles and application of some instrumental methods
Topics Covered	**Separation techniques:** Solvent extraction, distribution law, distribution constant, extraction of inorganic species, separation of metal ion as chelates, extraction of metal chlorides and nitrates, solid phase extraction. (4L) Ion exchange, ion exchange resin, ion exchange equilibria, application of ion exchange methods, home water softeners. (2L) Chromatography: general description of chromatography, classification of chromatography, elution of column chromatography, migration rates, distribution constants, relation between, volumetric flow rate and linear flow rates, retention factor, selectivity factor, rate theory of chromatography, a quantitative description of column efficiency, thin layer chromatography (TLC). (4L) Gas chromatography (GC), Instrumentation, Introduction, carrier gas system, sample injection system, column configurations and column oven, detection system, characteristic of ideal detector, FID, TCD, ECD, mass spectroscopy gas chromatography column and stationary phase, capillary, tubular column, packed column, liquid stationary phase, applications. (4L) High performance liquid chromatography: partition or liquid chromatography, adsorption or solid liquid chromatography, ion exchange or ion chromatography, size exclusion chromatography, and chiral chromatography. (4L) **Instrumental methods:** Thermoanalytical Techniques: thermogravimetric analysis (TGA), Introduction, principle, instrumentation, Factors affecting TGA, application, differential thermal analysis, principle, instrumentation, application. (4L) Electroanalytical techniques: electrogravimetry, electrical components, Galvanostat and potentiostat, principle, experiments, coulometry, principle, coulometer, coulometry cell, constant current coulometry. (4L) Polarography: Principal, process of current, polarographic cell, Ilkovic equation, half wave potential, experimental set up, application, quantitative and qualitative analysis. (4L) cyclic voltammetry: principal, cell configuration, instrumentation and circuit, application. (5L) Atomic absorption spectroscopy: Principle, Instrumentation, application. (3L)
Text Books, and/or reference material	1. Fundamentals of analytical chemistry, Skoog, West, Hollerand Crouch,8th edition, Thomson 2. Instrumental methods of analysis, Williard, Merit, Dean, Settle, CBS publishers &distributors 3. Inorganic electrochemistry, Theory practice and application, Piero Zanzello, RS.C

Mapping of COs (Course Outcomes) and POs (Programme Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	3	3	3	3	3	3	2
CO2	3	3	3	3	3	3	3	3	3	2	1	2
CO3	3	3	3	3	3	3	3	3	3	3	3	2

CURRICULUM AND SYLLABUS FOR INTEGRATED MSC IN CHEMISTRY

FIFTH SEMESTER

Course Code	Titleofthecourse	ProgramCore(PCR)/ Electives(PEL)	TotalNumberof contacthours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CYC501	**Fundamentals of Electrochemistry and Data Analysis**	PCR	3	1	0	4	4
Pre-requisites		Course Assessment methods [Continuous (CA), mid-term (MT) and end term (ET)]					
NIL		CA+MT+ET					

CourseOutcomes	**CO1**: Application of conductometric measurement. **CO2**: Understanding the dissociation of electrolytes in solution and its application. **CO3**: Electrochemical cell: principle and application. **CO4**: To be able to analyze the data using different statistical tools. **CO5**: To understand data fitting, applications in real life and computational techniques to perform data analysis.
TopicsCovered	**Electrochemistry:** **Conductance:** Electrolytic conduction, conductions of solutions: specific, equivalentand molar conductance, variation of molar conductivity with concentration for strong and weak electrolytes, Arrhenius theory of electrolytic dissociation, Debye-Hückel-Onsager theory of ionic atmosphere. (5L) Kohlrausch's law, transport number and its determination, abnormal transport number, Applications of conductance measurement, conductometric titrations. (5L) **Electrochemical cells:** Different types and evaluation of cell potential, variousfactors affecting the potential, determination of thermodynamic parameters,potentiometric titration, Application of EMF measurement. (5L) Concentration cell, liquid junction potential, commercial cells including fuel cell,Li ion battery, dye sensitized solar cell. (5L) **Data Analysis:** **Measure of central tendency:**Arithmetic mean, weighted mean, median, mode, geometric mean, harmonic mean for discrete, grouped, continuous data with merits, demerits, properties, application and numerical examples. (3L) **Measure of dispersion/variability/spread:**Range, mean deviation, standard deviation, variance, skewness, kurtosis etc for discrete, grouped, continuous data with properties, merits, demerits and application with numerical examples. (4L) **Moments:**Raw moments, central moments, relation between moments about mean and moments about any point and vice-versa, Sheppard's correlation for moments, Pearson's β, γ coefficients in terms of moments. (4L) **Curve fitting**: Covariance, Linear Regression: Least Square Curve fitting, Exponential curve fitting with examples etc. (2L) **Theoretical Discrete Distribution:** Bernoulli, Poisson, Binomial with their derivations of moments, skewness, kurtosis, various properties and numerical

	problems. Interrelation between these three distributions. (4L) **Theoretical Continuous Distribution:** Uniform, Gaussian, Central Limit Theorem with their derivations of moments, skewness, kurtosis, various properties and numerical problems. (2L) **Application of data analysis**: in Theoretical and Experimental research, Industry application. (2L) **Programming and Software Techniques:** Fortran programming, MATLAB/ MS Office Excel/ Mathematica library functions etc. (2L)
Text Books, and/or reference material	1. Physical chemistry by P. Atkins and J.de Paula 2. A text book of physical chemistry by K. L. Kapoor 3. Physical chemistry by P.C.Rakshit 4. Fundamentals of Mathematical Statistics (A Modern Approach) by S. C. Gupta and V. K. Kapoor, 10th Revised Edition 2000, Reprint 2002, Publisher: Sultan Chand & Sons, New Delhi

Mapping of COs (Course Outcomes) and POs (Programme Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	1	3	1	1	1	2	1	1	1	1
CO2	3	1	1	3	1	1	1	2	1	2	1	1
CO3	3	1	3	3	2	3	1	3	3	3	2	2
CO4	3	3	3	2	2	2	2	3	3	1	2	1
CO5	3	3	3	2	2	2	2	3	3	1	2	1

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CYC 502	**Chemistry in Solution and Solid State Chemistry**	PCR	3	1	0	4	4

Pre-requisites	Course Assessment methods [Continuous (CA), mid-term (MT) and end term (ET)]
NIL	CA+MT+ET

Course Outcomes	**CO1**: Understand different concepts of acids and bases **CO2**: Know about the thermodynamic aspects of Lewis acid and base interaction **CO3**: Understand the concept of redox reaction, standard redox potential **CO4**: Have concept of effect of concentration and pH on redox reaction **CO5**: Know basic idea of Inorganic solid and crystal **CO6**: Know the thermodynamics and energetics of stability of solid **CO7**: Born Lande equation and Kapustinskii equation, **CO8**: Crystal system and different types of unit cells and crystals in inorganic solid **CO9**: Defect of crystal and the associated property

Topics Covered	**Concept of acids and bases:** The Arrhenius concept, Concept of K_w, concept of pH, Strength of acids and bases(hydracids and oxyacids), levelling effect of water, solvent concepts, Bronsted Lowry concept, Lewis concepts. (5 L) Hard-Soft acid base concept, relation of hardness to ionisation potential and electronegativity and frontier orbital. (2 L) Thermodynamic of Lewis acid and base interaction, the Drago-Wayland equation. (1 L) Monoatomic ions and their acid –base properties, polyatomic ions and their acid-base properties. (1 L) **Redox Chemistry:** Redox reaction, ion electron balancing, standard reduction potential and their diagrammatic representation. (3 L) Redox predominance diagrams of elements, disproportionation and metastable state. (2 L) Redox chemistry and extraction of elements from ores. Ellingham diagrams. (2 L) Effect of concentration and pH on redox reaction, uses of redox series in chemical reaction, Pourbaix diagrams. (4 L) **Ionic equilibrium and precipitation reactions:** **Ionic compounds:** Factors effecting ionic radii, Fajans rule, lattice energy, Born Haber cycle and its application. (4 L) Born Lande equation, modification of Born-Lande equation, Kapustinskii equation, radius ratio rule. (4 L) **Solid State Chemistry:** Crystal system and lattices, unit cell, Miller planes, crystal packing, metallic bond. (4 L) ionic crystals, structures of AX, AX_2, AX_3, A_2X_3, type Structures of mixed metal oxides: spinel and inverse spinel, perovskite. (4 L) Crystal structure related to super conductivity, ferroelectric and piezo electric property, crystal defects, stoichiometric and nonstoichiometric defect, Schottkey and Frenkel defect, etc.Inorganic nanomaterial and polymers.(4 L)
Text Books, and/or reference material	1) Inorganic Chemistry, Part I ,R.L. Dutta New Book Stall 2) Fundamental concept of Inorganic Chemistry, vol 3, Asim K. Das, CBS publishers & distributors 3) Inorganic Chemistry, Huheey, Keiter, Keiter, Medhi, Pearson education 4) Inorganic chemistry, Shriver & Atkins, Oxford 5) Concept and models of inorganic Chemistry, Douglas, Mcdeniel, Alexander, Wiley IndiaPvt. Ltd. 6) Concise inorganic chemistry, Lee, Wiley India Pvt. Ltd.

Mapping of COs (Course Outcomes) and POs (Programme Outcomes)

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	--	1	1	3	2	1	2	1
CO2	3	3	3	3	--	1	1	3	2	1	2	1
CO3	3	3	3	3	--	1	1	3	2	1	2	1
CO4	3	3	3	3	--	1	1	3	2	1	2	1

CO5	3	2	3	3	--	1	1	3	2	1	2	1
CO6	3	3	3	3	--	1	1	3	2	1	2	1
CO7	3	3	3	3	--	1	1	3	2	1	2	1
CO8	3	3	2	2	--	1	1	3	1	1	2	1
CO9	3	3	3	3	--	1	1	3	2	1	2	1

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture(L)	Tutorial (T)	Practical (P)	Total Hours	
CYC503	**Chemistry of Heterocyclic Compounds**	PCR	3	0	0	3	3
Pre-requisites		Course Assessment methods [Continuous (CA), mid-term (MT) and end term (ET)]					
NIL		CA+MT+ET					

Course Outcomes	**CO1**: To learn various nomenclature processes of heterocyclic compounds **CO2**: To explain the basis of aromaticity, acidity-basicity of heterocyclic compounds **CO3**: To solve the mechanisms of synthesis and reactions of heterocyclic compounds **CO4**: To relate these concepts on study of heterocycles with two or more hetero atoms and two rings including purine & pyrimidine and their derivatives **CO5**: To apply the knowledge on some natural purines like uric acid, caffein etc. **CO6**: To investigate presence of heterocyclics in alkaloids
Topics Covered	Nomenclature of heterocycles, common nomenclature, replacement method, Hantzsch-Widman (IUPAC or Systematic) method. (4 L) Aromatic and nonaromatic heterocycles, moleculelar orbital picture and aromatic characteristics of pyrrole, furan, thiophene and pyridine and other small ring heterocycles. Comparison of basicity of pyridine, piperidine and pyrrole. (3 L) Generalized approach to the synthesis of heterocycles possessing 5, 6 and 7 membered rings with one or two heteroatoms. (3 L) Reactions of heterocycles: with particular emphasis on the mechanism of electrophilic substitution. Mechanism of nucleophilic substitution reactions in pyridine derivatives. Oxidation and reduction. (8 L) Fused five and six – membered heterocycles. Preparation and reactions of indole, quinoline and isoquinoline with special reference to Fisher indole synthesis, Skraup synthesis and Bischler- Napieralski synthesis. Mechanism of electrophilic substitution reactions of indole, quinoline and isoquinoline. (4 L) Five and six membered heterocycles with two or more hetero atoms. (4 L) Purine & pyrimidines: Structure, synthesis, reactions of adenine, guanin, thymine, uracil, cytosine, uric acid, caffein, xanthine. (8 L) An introduction to heterocyclic alkaloids. (2 L)
Text Books, and/or	<u>Suggested Text Books:</u> 1. Organic Chemistry, Volume 2: Stereochemistry and the Chemistry Natural Products, I. L. Finar, Pearson Education India, 2002.

reference material	2. Heterocyclic Chemistry, T. R. Gilchrist, Longman, 1989. 3. Topics in Heterocycles Chemistry. G. W. Gribble. Spinger-Verlag Berlin Heidelberg, 2010. Suggested Reference Books: 4. Modern Heterocyclic Chemistry. 4 Volume Set. Julio Alvarez-Builla, Juan Jose Vaquero, José Barluenga. Wiley. 2011. 5. Principles of Modern Heterocyclic Chemistry, L.A. Paquette, W.B. Benjamin, Inc., 1978. 6. Handbook of Heterocyclic Chemistry. Alan R. Katritzky and A. F. Pozharskii, Elservier, 2000. 7. The Chemistry of Heterocycles. T. Eicher, S. Hauptmann, Wiley-VCH 2003 8. Heterocyclic Chemistry, J.A.J. Joule and G.F. Smith, ELBS, 2nd Ed., 1982.

Mapping of COs (Course Outcomes) and POs (Programme Outcomes)

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	3	3	1	1	3	3	3	1	3	2
CO2	3	2	2	3	1	2	3	3	2	1	3	1
CO3	3	3	3	3	3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3	3	3
CO6	3	3	3	3	3	3	3	3	3	3	3	3

Course code	Title of the course	Program Core (PCR)/Electives (PEL)	Total number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total hours	
CYC504	**Industrial Chemistry**	PCR	3	0	0	3	3
Pre-requisites		Course Assessment methods [Continuous (CA), mid-term (MT) and end term (ET)]					
NIL		CA+MT+ET					
Course outcomes	**CO1**: To understand the applications of chemistry in the industrial set-up **CO2**: To develop the basic knowledge of fuel, polymers and their applications **CO3**: To learn about few engineering materials such as paints-pigments, cementing materials, glass, ceramics **CO4**: To apply biotechnology in solving some day today problems **CO5**: To apply different chemical tools which are useful and valued in industry **CO6**: To apply the chemistry knowledge for solving industrial problems						
Topics covered	**Fuel:** Coal, Petroleum, Gaseous fuels and Biofuels (including industrial process for liquefaction of coal, distillation of petroleum, analysis of coal). (8 L) **Polymers:** Types, structures and synthesis polymers, Molecular weights of polymers, Poly dispersity index, degree of polymerization, natural rubber, vulcanization, thermosetting plastics, industrial polymers and their chemistry. (6 L) **Paints and pigments:** Introduction, definitions, types, emulsions, additives, anti-corrosion properties, chemical formulas and compositions. (5 L) **Cementing materials:** Lime (types, manufacture, properties and applications); Cement -Types, different types						

	of industrial preparations, composition and chemistry. (5 L) **Glass and ceramics:** Different types of glass and ceramics, and their chemical compositions, reactions, chemical properties. (5 L) **Biotechnology Industry:** Introduction, Bioremediation of chemical waste, Bioleaching of ores, Biocatalyst, Fermentation, production of vinegar, Biofuel. (6 L)
Text Books, and/or reference materials	1. Industrial inorganic Chemistry by K. H. Büchel, H. H. Moretto, P. Woditsch 2. Industrial Chemistry by B. K. Sharma 3. Biotechnology in the Chemical Industry: Towards a Green and Sustainable Future by P. Bazpai 4. Engineering Chemistry, 2nd Edition, Wiley

Mapping of COs (Course Outcomes) and POs (Programme Outcomes)

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	3	3	2	2	1	3	3	3	2	2
CO2	3	1	3	3	3	2	1	3	3	3	2	2
CO3	3	1	3	3	3	2	1	3	3	3	2	2
CO4	3	3	3	3	3	2	1	3	3	3	2	2
CO5	3	3	3	3	3	3	3	3	3	3	2	2
CO6	3	3	3	3	3	3	2	3	3	3	2	2

CourseCode	Titleofthecourse	ProgramCore(PCR)/ Electives(PEL)	TotalNumberof contacthours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CYC505	**Ionic Equilibrium and Surface Chemistry**	PCR	3	0	0	3	3
Pre-requisites		Course Assessment methods [Continuous (CA), mid-term (MT) and end term (ET)]					
NIL		CA+MT+ET					
CourseOutcomes	**CO1**: Understanding the concept of ionic equilibrium. **CO2**:Applying the concept of activity and solubility product. **CO3**: Analysing the concept of adsorption to estimate catalytic efficiency. **CO4**: Applying the basics of surfactant science toward household and industrial activities. **CO5**: Understanding the basics of nano science. **CO6**: Evaluation the potentiality of nanomaterials towards various applications.						
TopicsCovered	**Ionic equilibrium:** Concept of pH, pH of strong and weak acids and bases, hydrolysis of salts, buffer solutions, buffer capacity, pH metric titration, acid-base indicator and indicator constant, relations among activity, concentration and activity coefficient, Ionic						

	strength of electrolytic solution, Debye-Huckel law (derivation excluded), determination of activity coefficient, activity and solubility product, application towards group separation of cations, common ion and salt effect on the solubility of sparingly soluble salts. (6L) **Adsorption:** Thermodynamics of adsorption, Physisorption and chemisorption, Isosteric heat of adsorption, Langmuir, BET (derivation not required), Gibbs adsorption isotherms. Competitive adsorption. Surface tension and surface pressure, Cohesion, adhesion, capillary action, Contact angle, interfacial tension, Concept of Hysteresis. Application of adsorption: Estimation of surface area of solids, Removal of contaminants from polluted water and others. (6 L) Rate expression of the heterogenous surface catalyzed reactions. Catalytic poisons and promoters. (3L) **Micellar system:** Concept of micelle, reverse micelle and microemulsion, hydrophobic effect, factors affecting CMC, determination of CMC, Thermodynamics of micellisation, micellar aggregation number and fraction of counter ions bound to a micelle. Application of surfactants. (8L) **Colloidal system:** Theory of electrical double layer, zeta potential. How zeta potential is measured.Colloids: classification of colloidal systems, stability of colloids, their properties and applications. (4 L) Concept of nanoparticle, Metal-organic and Carbon-organic framework. (4 L)
Text Books, and/or reference materials	1. Physical chemistry by P. Atkins and J.de Paula 2. Physical chemistry by Laidler and Meiser 3. A text book of physical chemistry by K.L.Kapoor 4. Introduction to applied colloid and surface chemistry by G. M. Montogeorgis and S. Kill (Wiley) 5. Physical Chemistry of surfaces by A. W. Adamson and A. P. Gast (Wiley India)

Mapping of COs (Course Outcomes) and POs (Programme Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	2	3	2	1	1	2	2	2	1	1
CO2	3	1	1	2	1	1	1	2	1	2	1	1
CO3	3	1	3	3	2	2	1	3	3	3	2	2
CO4	3	3	3	2	2	1	1	2	3	2	2	2
CO5	3	3	3	2	2	1	1	2	3	2	3	3
CO6	3	3	3	2	2	1	1	2	3	2	3	3

CURRICULUM AND SYLLABUS FOR INTEGRATED MSC IN CHEMISTRY

Course Code	Title of the course	Program Core (PCR)/ Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CYS551	**Chemical Kinetics, Surface Chemistry and ConductometricAnalysis**	PCR (Practical)	0	0	3	3	2

Pre-requisites	Course Assessment methods: [Continuous evaluation (CE) and end assessment (EA)]
NIL	CE+EA

Course Outcomes	**CO1**:Monitoring kinetics of reactions by various experimental methods. **CO2**:Evaluation of adsorption isotherm. **CO3**:Knowledge of conductometric estimation. **CO4**:developmentoflaboratoryskill,datahandlingandinterpretation,erroranalysis.
Topics Covered	1. Determination of rate constant of inversion of sucrose 2. Determination of rate constant of hydrolysis of ester by conductometry 3. Study of the kinetics of the reaction between $K_2S_2O_8$ and KI, determination of rate constant and influence of ionic strength on it 4. Kinetic study of iodine clock reaction 5. Determination of amount of acetic acid adsorbed by charcoal and evaluation of adsorption isotherm 6. Conductometric determination of strength of acid in a mixture 7. Verification of Ostwald dilution law 8. Measurement of interfacial tension by contact angle measurement. 9. Determination of CMC of ionic surfactant by conductometric method. Any other practical as assigned by the Instructor
Text Books, and/or reference materials	1. Instruction manual provided by the Instructor 2. Selected experiments in Physical Chemistry By N.G.Mukherjee 3. Advanced Physical Chemistry Experiments: By Gurtu & Gurtu

Mapping of COs (Course Outcomes) and POs (Programme Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	1	3	1	1		2	1	1	2	1
CO2	3	1	1	3	1	1		2	1	1	2	1
CO3	3	1	1	3	1	1		2	1	1	3	1
CO4	1	1	1	3	1	1		2	2	1	2	1

CURRICULUM AND SYLLABUS FOR INTEGRATED MSC IN CHEMISTRY

Course Code	Title of the course	Program Core (PCR)/ Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CYS552	**Quantitative Estimation of Metal ions in Mixture**	PCR (Practical)	0	0	4	4	2

Pre-requisites	Course Assessment methods: [Continuous evaluation (CE) and end assessment (EA)]
NIL	CE+EA

Course Outcomes	**CO1**: Basic concepts of quantitative estimation **CO2**: Understand to evaluate the estimation of ion mixture **CO3**: Understand the fundamental, scientific basis, preparation of sample, sampling method and analytical methods.
Topics Covered	1. Permanganometry: Fe(III) and Mn(II) in a mixture. 2. Dichromatometry: Fe(III) and Cu(II) in a mixture; Fe(III) and Cr(III) in a mixture. 3. Complexometry: $CaCO_3$ and $MgCO_3$ in mixture; Mg(II) and Zn(II) in mixture using EDTA; Complexometric estimation of sulphate and phosphate ion; 4. Analysis of four components mixture (Al^{+3} , Fe^{+3} , Co^{+2} , Ni^{+2}). 5. Gravimetric estimation of $Ni(DMG)_2$ Some more experiments as decided by the Instructor.
Text Books, and/or reference material	1. An Advanced Course in Practical Chemistry by Nad, Ghosal and Mohapatra, New Central Book agency. 2. A Manual of Practical Chemistry for Degree Classes (Vol I & II) by R. C. Bhattacharya, 3. College Practical chemistry by Ahluwalia, Dingra and Gulati. 4. Vogels textbook of quantitative chemical analysis By J. Mendham, R. C. Denney, M. Thomas and D. J. Barnes, Pearson India. 5. APHA, A, WEF, (1998). Standard Methods for the Examination of Water and Wastewater. American Public Health Association, American Water Works Association,Water Pollution Control Federation, Washington DC.

Mapping of COs (Course Outcomes) and POs (Programme Outcomes)

POs **COs**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	2	3	1	2	--	2	3	2	3	1
CO2	3	3	2	3	1	2	--	1	3	2	3	1
CO3	3	3	2	3	--	2	1	2	3	2	3	1

CURRICULUM AND SYLLABUS FOR INTEGRATED MSC IN CHEMISTRY

Course code	Title of the course	Program Core (PCR)/Electives (PEL)	Total number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total hours	
CYS553	**Quantitative Analysis of Organic Samples**	PCR (Practical)	0	0	3	3	2
Pre-requisites		Course Assessment methods: [Continuous evaluation (CE) and end assessment (EA)]					
NIL		CE+EA					
Course outcomes	**CO1**: A basic idea about the methodology of quantitative analysis of organic compounds. **CO2**: Concept about the uses of reagents and solvents for quantitative analysis of organic compounds **CO3**: The uses of these quantitative analysis for important compounds						
Topics covered	1. Estimation of organic samples with carbonyl group. 2. Estimation of reducing sugar by Felhling's solution. 3. Estimation of vitamin C (ascorbic acid). 4. Estimation of phenol by bromination method. 5. Estimation of protein by Bradford method. 6. Analysis of organic sample by GC-MS. 7. Analysis of peptides and sugars using HPLC. 8. Estimation of C, H, N and S present in organic sample by CHNS analyzer.						
Text Books, and/or reference materials	1. Textbook of Practical Organic Chemistry by Vogel 2. Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis by Ahluwalia 3. An Advanced Course in Practical Chemistry by A. K. Nad, B. Mahapatra & A. Ghoshal						

Mapping of COs (Course Outcomes) and POs (Programme Outcomes)

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	2	3	2	2	2	3	2	3	3
CO2	2	2	3	3	2	2	3	2	3	1	3	3
CO3	3	3	3	2	1	3	2	3	2	2	3	3

CURRICULUM AND SYLLABUS FOR INTEGRATED MSC IN CHEMISTRY

SIXTH SEMESTER

Course Code	Title of the course	Program Core (PCR)/ Electives(PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CYC601	**Basics of Photochemistry, Spectroscopyand dGroup Theory**	PCR	3	1	0	4	4
Pre-requisites		Course Assessment methods [Continuous (CA), mid-term (MT) and end term (ET)]					
NIL		CA+MT+ET					
Course Outcomes	**CO1**:Physical understanding of photochemistry and photophysical processes. **CO2**:Fundamentals of different molecular spectroscopy. **CO3**: Introduction to symmetry and concept of point group.						
Topics Covered	**Photochemistry: (12 L)** Lambert-Beer's law and its application, Basics of photochemical reactions, primary processes, reactions of electronically excited species; law of photochemical equivalence, Franck-Condon principle, fluorescence and phosphorescence, Jablonsky diagram, Factor affecting fluorescence, quenching, basic techniques of absorption and emission spectroscopy, Concept of excited state life-time. **Basics of spectroscopy: (12 L)** Basic mechanism of spectroscopy, Elementary idea of rotational spectroscopy, Classification of molecules according to moment of inertia, Rotational quantum number, rotational energy levels, selection rule, Introduction to vibrational spectroscopy, energy levels, selection rule, Morse potential. Introductionto the electronicspectroscopy. **Symmetry and group theory: (12 L)** Introduction of symmetry and point groups, symmetry operations. Reducible and Irreducible representation and character table, Few applications of symmetry.						
Text Books, and/or reference materials	1. Modern molecular photochemistry by N. J. Turro 2. Fundamentals of molecular spectroscopy by Banwell 3. Fundamentals of photochemistry by Rohatgi-Mukherjee 4. Molecular symmetry and Group theory by R. L. Carter						

Mapping of COs (Course Outcomes) and POs (Programme Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	1	1	1	1	3	1	1	1	1
CO2	3	3	1	2	1	1	1	3	1	2	2	2
CO3	3	3	1	2	1	1	1	3	3	1	1	2

CURRICULUM AND SYLLABUS FOR INTEGRATED MSC IN CHEMISTRY

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CYC602	**Coordination Chemistry**	PCR	3	1	0	4	4

Pre-requisites	Course Assessment methods [Continuous (CT), mid-term (MT) and end assessment (EA)]
NIL	CA+MT+EA

Course Outcomes	**CO1**: Concepts of coordination complexes, ligand types and isomerism **CO2**: Theories of bonding (e.g. VBT, CFT, MOT) **CO3**: Application of CFT and MOT to explain the spectroscopic and magnetic properties of metal-ligand complexes. **CO4**: Spectroscopic Term symbols, Orgel diagram and Tanabe Sugano diagram **CO5**: Circular dichroism, optical rotatory dispersion, cotton effect **CO6**: Electronic spectral properties of Lanthanides and actinides
Topics Covered	Bloomstrand-Jorgensen's chain theory, Warner's theory of coordination compounds, double salts and complex salts, perfect and imperfect complexes, detection and evidence of complex formation in solution. (4L) Classification of Ligands, Inner-metallic complex, Poly nuclear or bridged complexes, Nomenclature of coordination compounds (4L) Structure, isomerism and stereochemistry, structural isomerism, conformational isomerism, stereoisomerism, geometric isomerism, optical isomerism (4L) Theories of bonding: Valence bond theory, crystal field theory, Factor effecting the crystal field splitting parameter, pairing energy and controlling the pairing energy, CFT and octahedral complexes, CFT and tetrahedral complexes, CFT and TPB and square pyramidal complexes, Tetragonal distortion, in octahedral symmetry, Jahn-Teller distortion, CFT and square planer complex, Application of CFT. (8L) Molecular orbital Theory of Octahedral, tetrahedral and square planer complexes, spectrochemical series and nephelauxeic series.(4L) Electronic spectra of transition metal complexes: Type of electronic spectra, selection rules, Relaxation of selection rule, band intensity, band width, symmetric and asymmetric bands. (3L) Spectroscopic term symbols, Orgel diagram, examples, limitation of orgel diagram. (5L) Tanabe Sagano diagram, Charge Transfer spectra, Intervalence electron transfer bands. (3L) Circular dichroism, optical rotatory dispersion, cotton effect. (3L) Electronic spectra of lanthanide and actinide complexes. (2L)

Text Books, and/or reference material	1) Inorganic Chemistry, Part I,R.L. Dutta, New Book Stall 2) Fundamental concept of Inorganic Chemistry, vol 4 & 5, Asim K. Das, CBS publishers & distributors 3) Inorganic Chemistry, Huheey, Kieter, kieter, Medhi, Pearson education 4) Inorganic chemistry, Shriver & Atkins, Oxford 5) Concept and models of inorganic Chemistry, Douglas, Mcdeniel, Alexander, Wiley IndiaPvt. Ltd. 6) Concise inorganic chemistry, Lee, Wiley IndiaPvt. Ltd. 7) Inorganic Chemistry by Housecroft and Sharp. 8) Principles of Inorganic Chemistry by B. W. Pfennig

Mapping of COs (Course Outcomes) and POs (Programme Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	3	3	2	1	2	3	3	2	1	1
CO2	2	2	3	2	2	2	2	3	3	1	1	1
CO3	2	3	3	2	2	3	2	3	3	3	1	1
CO4	2	2	3	2	2	3	2	3	3	2	1	1
CO5	3	2	3	2	2	3	2	3	3	3	1	1
CO6	3	2	3	2	2	3	2	3	3	3	1	1

Course Code	Titleofthecourse	Program Core(PCR)/Electives(PEL)	TotalNumberofcontacthours				Credit
			Lecture(L)	Tutorial (T)	Practical(P)	TotalHours	
CYC603	**Reagents inOrganicSynthesis**	PCR	3	1	0	4	4

Pre-requisites	CourseAssessmentmethods[Continuousassessment (CA),mid-term(MT)andendterm(ET)]
NIL	CA+MT+ET

CourseOutcomes	**CO1**:Abasicidea onsynthesisoforganiccompoundshasbeenincorporatedusingsomespecificreagentsfor particularcompoundsynthesis. **CO2**:Howthebetteryieldcouldbeobtained,theirstrategyhasbeenhighlighted. **CO3**:Roleofspecificreagentsandcatalystsincludingmechanismintheirtransformation fromsubstrateto productsisincluded for their step bystepsynthesis. **CO4**: Learn about the organic reaction mechanism and the role of reagents for better yield. **CO5**: Proper choice of solvent for the better yield and Industrial application for commercialization

TopicsCovered	Some important reactions with reagents: Aromatic electrophilic (Friedel-Craftreaction) and nucleophilic substitution reactions, Cine substitution reactions,AldolandMichaelcondensationreactions,Robinsonannulationreaction;Synthesisofbio-moleculeslikesteriodOestrone-1,±ZearalenoneandIsonotkatoneviaRetrosynthesis. (9L) Protectionanddeprotectionoffunctionalgroups;Ring expansion and ring contraction reactions; Regio-selective and enantio-selective reactions controlled by special reagents, Assymmetric synthesis byOxazolinederivatives,bis-lactoneetherbasedchiralauxiliary.(9L) Special reagents and reactions: Barton reaction, Wittig reaction; Peterson'ssynthesis(olefination);2,3-dichloro-5,6-dicyano-1,4benzoquinone(DDQ);Umpolung reactivity (1,3-Dithianes); Dicyclohexyl-carbodiimide (DCC); OsO_4;Woodward and Prevost hydroxylation; SeO_2; Phase transfer catalyst, purplebenzene,cryptatesandclathrochelates;Wilkinsoncatalyst;hydroformylationreactionsorOxoreactions;Sapiroreaction;Favoriskireactions; Hoffmann-Löffler reaction; Baker's yeast (enzymatic reduction) andGilmanreagents. (9L) Specialreagentsusedinoxidationandreductionorganictransformationreactions: Oxidation reaction: CrO_3, pyridine complex, Mn(IV) oxide,RuO_4,Sharplessepoxidation,Moffatoxidation,Swernoxidation,Dess-Martinperiodinaneoxidation.Reduction reaction: hydride transfer reagents: DIBAL;Na(CN)BH;Trialkylborohydrides;trialkyltinhydride;Lowvalenttitanium(II)oxide,diimide. (9L)
Text Books,and/orreference material	**SuggestedTextBooks:** (i)ModernMethodsofOrganicSynthesis4thEdition,W.CarruthersCambridgeUniversityPress (ii) ReactionMechanisminOrganicChemistry:S.M.MukherjiandS.P.Sinha;MacmillanIndiaPvtLtd. (iii) OrganicsynthesisThroughDisconnectionApproach:P. S.Kalsi (iv) ModernsyntheticreactionsbyH.O.House. (v) PrinciplesofOrganicsynthesis:R.O.C.NormanandJ.M.Coxon;CRCPress

Mapping of COs (Course Outcomes) and POs (Programme Outcomes)

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	2	3	2	2	3	3	2	3	2
CO2	2	3	3	3	2	2	3	2	3	3	2	2
CO3	3	3	3	2	1	3	2	3	2	2	1	2
CO4	2	3	1	3	2	2	3	2	1	2	1	2
CO5	3	1	2	1	3	2	2	3	2	1	1	3

CURRICULUM AND SYLLABUS FOR INTEGRATED MSC IN CHEMISTRY

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
HSC631	**Economics and Management Accountancy**	PCR	3	0	0	3	3

Pre-requisites	Course Assessment methods [Continuous assessment (CA), mid-term (MT) and end term (ET)]
NIL	CA+MT+ET

Course Outcomes	**CO1:** Toreviewbasiceconomicprincipleswithstudents **CO2:** Tointroducestudentsbasiccapital appraisal methodsusedforcarryingout economic analysis of different alternatives of engineering projects or works **CO3:** Toeducatethestudentsonhowtoevaluatesystematicallythevariouscost elementsofatypicalmanufactured product, anengineering project orservice, withaviewtodeterminingthepriceoffer.
Topics Covered	**PART 1: Economics** **Group A: Microeconomics** Unit 1: Economics: Basic Concepts (2 L) Unit 2: Theory of Consumer Behaviour (3 L) Unit 3: Theory of Production, Cost and Firms(3 L) Unit 4: Analyses of Market Structures: Perfect Competition (3 L) Unit 5: Monopoly Market (1 L) Unit 6: General Equilibrium &Welfare Economics (2 L) **Group B: Macroeconomics** Unit 1: Introduction to Macroeconomic Theory (2 L) Unit 2: National Income Accounting (3 L) Unit 3: Determination of Equilibrium Level of Income (4 L) Unit 4: Money, Interest and Income (2 L) Unit 5: Inflation and Unemployment (2 L) Unit 6: Output, Price and Employment(2 L) **PART 2: Accountancy** Unit 1: Introduction to Accounting (2 L) Unit 2: Primary Books of Accounts (Journal) (1 L) Unit 3: Secondary Books of Accounts (Ledger)(3 L) Unit 4: Cash Book (2 L) Unit 5: Bank Reconciliation Statement (1 L) Unit 6: Trial Balance (2 L) Unit 7: Final Accounts (2 L)
Text Books, and/or reference material	Suggested Text Books: **PART 1: Economics** **Group A: Microeconomics** 1. Koutsoyiannis: Modern Microeconomics 2. Maddala and Miller: Microeconomics 3. AnindyaSen: Microeconomics: Theory and Applications 4. Pindyck&Rubenfeld: Microeconomics **Group B: Microeconomics** 1. W. H. Branson: Macroeconomics – Theory and Policy (2nd ed) 2. N. G. Mankiw: Macroeconomics, Worth Publishers 3. Dornbush and Fisher: Macroeconomic Theory

	4. SoumyenSikder: Principles of Macroeconomics **PART 2: Accountancy** 1. Gupta, R. L. and Radhaswamy, M: Financial Accounting; S. Chand & Sons 2. Ashoke Banerjee: Financial Accounting; Excel Books 3. Maheshwari: Introduction to Accounting; Vikas Publishing 4. Shukla, MC, Grewal TS and Gupta, SC: Advanced Accounts; S. Chand & Co.

Mapping of COs (Course Outcomes) and POs (Programme Outcomes)

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	1	-	-	3	-	-	3	2	1	-
CO2	3	2	-	1	-	2	-	2	-	-	3	1
CO3	-	-	-	-	1	-	3	-	-	-	2	-

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CSC631	**Artificial Intelligence and Machine Learning**	PCR	3	0	2	5	4

Pre-requisites	Course Assessment methods (Continuous evaluation (CE) and endassessment (EA))
Basic Concepts of Probabilityand Statistics, Knowledge ofAlgorithm analysis	CE+EA

Course Outcomes	**CO1**: Identify problems where artificial intelligence (AI) techniques are applicable **CO2**: Understand to apply search strategies to solve the problems. **CO3**: Principal models used in machine learning and apply them in machine learning to appropriate problems **CO4**: Formulate valid solutions for problems involving uncertain inputs or outcomes by using decision making techniques. **CO5**: Understanding different supervised and unsupervised learning methods.

Topics Covered	**Introduction to Artificial Intelligence (AI):** What is Intelligence, Reasoning andPlanning, Learning and Adaptation, and interaction with the real world, A briefhistory of AI, Application areas of AI, State of the art. (2 L) **Problem solving by search:** Problem types, Illustrative search problems; SearchSpace, Search tree; BFS, DFS, UCS; Local search; Hill climbing; Heuristics; A*search (6 L) **Knowledge Representation:** Propositional, predicate logic, first order logic,resolution and unification (5 L) **Reasoning under Uncertainty:** Conditional independence representation, exactinference through variable elimination, and approximate inference throughsampling. (5 L) **Introduction to Machine Learning:** Basic concepts, bias-variance trade off,evaluation metrics etc. (2 L) **Supervised Learning:** Simple linear regression, multiple linear regression,logistic regression, support vector machine, decision trees, Introduction to artificialneural network. (14 L) **Unsupervised Learning:** Clustering algorithms, k-means/k-medoid, hierarchicalclustering (6 L) **Dimensionality reduction:** Principal component analysis. (2 L)
Topics Covered	**Sessional experiments:** Study of PROLOG programming language to implementdifferent search techniques, Implementation of different machine learningtechniques (linear and logistic regression; Decision Trees**;** Support VectorMachine; artificial neural network; Clustering techniques) by programming inPython
Text Books, and/or reference material	**Text Books:** 1.Artificial intelligence: A Modern Approach- Stuart Russell, Peter Norvig, Prentice Hall,Fourth edition, 2020 2. Tom M. Mitchell, “Machine Learning”, McGraw Hill Education, International Edition,2010 **Reference Books:** 1. Elaine Rich, Kevin Knight and Shivashankar B. Nair, “Artificial Intelligence”, Tata McGraw Hill, 3rd Edition 2017. 2. Ethem Alpaydin, “Introduction to Machine Learning”, Third Edition, MIT Press, 2014

Course Code	Title of the course	Program Core (PCR)/ Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CYS651	**Potentiometric and Colorimetric Analysis**	PCR (Practical)	0	0	3	3	2

Pre-requisites	Course Assessment methods: [Continuous evaluation (CE) and end assessment (EA)]
NIL	CE+EA

Course Outcomes	**CO1**:Handling spectrophotometer and knowledge on its application. **CO2**:Construction of electrochemical cell and measuring cell potential. **CO3**:Application of potentiometric estimation. **CO4**:Development of laboratory skill, data handling and interpretation,error analysis.
Topics Covered	1. Verification of Beer's law 2. Determination of E^0 of quinhydrone electrode 3. Determination of phosphate concentration in a soft drink 4. Estimation of dissociation constant of acetic acid potentiometrically 5. Titration of Mohr's salt solution and determination of formal potential of Fe^{3+}/Fe^{2+} system 6. Determination of Solubility product of silver chloride potentiometrically Any other practical as assigned by the Instructor
Text Books, and/or reference material	1. Instruction manual provided by the Instructor 2. Selected experiments in Physical Chemistry By N.G.Mukherjee 3. Advanced Physical Chemistry Experiments: By Gurtu & Gurtu

Mapping of COs (Course Outcomes) and POs (Programme Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	1	3	1	2	-	2	1	2	2	1
CO2	3	1	1	3	1	2	-	2	1	2	2	1
CO3	3	1	1	3	1	2	-	2	1	2	3	1
CO4	1	1	1	3	1	1	-	2	2	1	2	1

Course Code	Title of the course	Program Core (PCR)/ Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CYS652	**Analysis of Ores and Alloys**	PCR (Practical)	0	0	4	4	2
Pre-requisites		Course Assessment methods: [Continuous evaluation (CE) and end assessment (EA)]					
NIL		CE+EA					
Course Outcomes	**CO1**: Basic concepts of Ores and alloys **CO2**: Understand to evaluate the analysis of different ores and alloys **CO3**: Understand the fundamental, scientific basis, preparation of sample, sampling method and analytical methods.						
Topics Covered	Analysis of a) High speed steel; b) Dolomite; c) Brass; d) Bronze; e) Bauxite; f) Pyrolusite;						

Text Books, and/or reference material	1. An Advanced Course in Practical Chemistry by Nad, Ghosal and Mohapatra, New Central Book agency. 2. A Manual of Practical Chemistry for Degree Classes (Vol I & II) by R. C. Bhattacharya, 3. College Practical chemistry by Ahluwalia, Dingra and Gulati. 4. Vogels textbook of quantitative chemical analysis By J Mendham, R. C. Denney, M. Thomas and D. J. Barnes, Pearson India.

Mapping of COs (Course Outcomes) and POs (Programme Outcomes)

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	3	1	2	--	2	3	2	3	1
CO2	3	3	2	3	1	2	--	1	3	2	3	2
CO3	3	3	2	3	--	2	1	2	3	2	3	2

CURRICULUM AND SYLLABUS FOR INTEGRATED MSC IN CHEMISTRY

Course code	Title of the course	Program Core (PCR)/Electives (PEL)	Total number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total hours	
CYS653	**Single Step Organic Synthesis Laboratory**	PCR (Practical)	0	0	4	4	2
Pre-requisites		Course Assessment methods: [Continuous evaluation (CE) and end assessment (EA)]					
NIL		CE+EA					
Course outcomes	**CO1**: To reach a targeted product through single step reaction process using suitable reagents and optimum reaction conditions. **CO2**: To learn separation and purification of products **CO3**: To learn purification techniques, like phase transfer, crystallization, GC-MS and other spectroscopic method will be adopted **CO4**: To learn the basic concept behind separation process for most common spectroscopic method like; UV-Vis, FT-IR, NMR, ESI-MS and GC-MS. **CO5**: To learn how to reach a maximum yield with minimum uses of solvent, reagents and energy like; heat and electricity (Green chemistry).						
Topics covered	1. Acetylation of primary amine. 2. Base mediated Aldol condensation reaction. 3. Rearrangement of benzyl to benzylic acid. 4. Pechmann condensation for coumarin synthesis. 5. Bromination of acetanilide. 6. Synthesis of dihydropyrimidinone. 7. Preparation of benzopinacol from benzophenone. 8. Synthesis of pinacolone from pincaol via rearrangement reaction.						
Text Books, and/or reference materials	1. Vogel's Textbook of practical organic chemistry 2. Advanced practical chemistry by S. C. Das 3. An Advanced Course in Practical Chemistry by A. K. Nad, B. Mahapatra & A. Ghoshal						

Mapping of COs (Course Outcomes) and POs (Programme Outcomes)

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	1	3	3	3	1	2	3	2	3	3
CO2	3	3	3	2	2	3	1	3	2	2	3	3
CO3	3	2	3	2	2	2	2	3	2	3	3	3
CO4	3	3	3	2	2	3	3	3	2	3	3	3
CO5	3	3	3	3	2	3	3	3	2	3	3	3

CURRICULUM AND SYLLABUS FOR INTEGRATED MSC IN CHEMISTRY

SEVENTH SEMESTER

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
MSC731	**Principles of Management**	PCR	3	0	0	3	3
Pre-requisites		Course Assessment methods [Continuous (CA), mid-term (MT) and end Term (ET)]					
		CA+MT+ET					

Course Outcomes	**CO1**:To make budding engineers aware of various management functions required for any organization **CO2**:To impart knowledge on various tools and techniques applied by the executives of an organization **CO3**:To make potential engineers aware of managerial function so that it would help for their professional career **CO4**:To impart knowledge on organizational activities operational and strategic both in nature **CO5**: To impart knowledge on each functional area of management like Marketing, Finance, Behavioral Science and Quantitative Techniques and decision science
Topics Covered	**UNIT I:** Management Functions and Business Environment: Business environment- macro, Business environment -micro; Porter's five forces, Management functions – overview, Different levels and roles of management, Planning- Steps, Planning and environmental analysis with SWOT, Application of BCG matrix in organization (12 L) **UNIT II:** Quantitative tools and techniques used in management: Forecasting techniques, Decision analysis. (6 L) **UNIT III:** Creating and delivering superior customer value: Basic understanding of marketing, Consumer behavior-fundamentals, Segmentation, Targeting & Positioning, Product Life cycle. (8 L) **UNIT IV:** Behavioral management of individual: Motivation, Leadership, Perception, Learning. (8 L) **UNIT V:** Professional ethics: Introduction to Professional ethics, Morals, values and Ethics, Ethics in Business. (2 L)
Text Books, and/or reference material	1. Marketing Management 15th Edition, Philip Kotler and Kelvin Keller, Pearson India 2. Management Principles, Processes and practice, first edition, Anil Bhat and Arya Kumar, Oxford Higher education 3. Organizational Behavior,13th edition, Stephen P Robbins, Pearson Prentice Hall India 4. Operations Management, 7th edition (Quality control, Forecasting), Buffa & Sarin, Willey 5. A.C. Fernando: Business Ethics & Corporate Governance, Pearson Education2nd edition

CURRICULUM AND SYLLABUS FOR INTEGRATED MSC IN CHEMISTRY

Mapping of COs (Course Outcomes) and POs (Programme Outcomes)

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	-	-	-	-	2	-	2	1	1	3
CO2	-	-	-	-	-	-	1	-	1	-	-	3
CO3	-	-	-	-	-	-	1	2	2	2	2	3
CO4	-	-	-	-	-	-	1	2	2	1	1	3
CO5	-	-	-	-	-	-	2	2	2	2	1	3

CourseCode	Titleofthecourse	ProgramCore(PCR)/Elective (PEL)	TotalNumberof contacthours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CYC701	**Quantum Chemistry**	PCR	3	1	0	4	4
Pre-requisites		Course Assessment methods [Continuous (CA), mid-term (MT) and end Term (ET)]					
NIL		CA+MT+EA					
CourseOutcomes	**CO1**:To understand thedifferencebetweenmacroscopic (classical) and microscopic(quantum) world, quantization of energy, wave particle duality. **CO2**:ApplyingSchrödingerwaveequation to modelquantumsystems. **CO3**: To apply Schrödingerwaveequation for one electron system (Hydrogen atom) in spherical polar coordinates. **CO4**:To analyze the vibrational, rotational spectra of diatomic molecules form quantization of energy concept. **CO5**: To understand the mathematical background of the concept of electron spin, angular momentum, uncertainty principle, Pauli's exclusion principle **CO6**: To apply mathematical concepts (vectors, matrix, differential equations, polynomials etc.) to problems of quantum mechanics						
TopicsCovered	**Introduction to Quantum Mechanics:** The dawn of quantum theory, black body radiation, photoelectric effects, Atomic spectra, vibrations in atomic crystals, wave particle duality, Heisenberg uncertainty principle, Time-independent Schrödinger equation (5L) **Postulates of Quantum Mechanics:** Fundamental operations of quantum mechanics, eigenvalue problems, wavefunctions and probabilistic representation, operators, average values, commutation relations, time-dependent Schrodinger equation (5L) **Simple applications (exactly solvable problems):** Particle in a 1D & 3D box, particle in a box of finite depth, Tunnelling effect. (3L) **The Harmonic Oscillator:** Energy levels, Infrared spectra of diatomic molecules, wavefunctions (3L) **Particle on a sphere (rigid rotator):** Rigid rotator model of a diatomic molecule, Energy levels, rotation-vibration spectra, spherical harmonics (4L) **The Hydrogen Atom**: The Schrodinger equation for a hydrogen atom, energy levels, H atomic spectra, radial wave equations, atomic orbitals, Magnetic effect on electron movement (4L) **Generalized Uncertainty Principle, Angular Momentum:** Angular momentum and its measurements (2L) **Electronic wavefunction with spin-Pauli's exclusion Principle**						

	Electron spin, spin-orbit interaction, Atomic Term Symbols, The Schrodinger equation for a Helium atom (3L) **Approximation methods:** Basic principles of variation and perturbation methods. (1L) **Mathematical Concepts:** Representation of complex number, Euler's formula, series and limits, average values etc. (2L) **Linear algebra in quantum mechanics and symmetry operation:** Vector space, determinants, matrix and liner transformations, orthogonal transformation, symmetry operations, matrix eigenvalue problem etc. (3 L) **Partial differential equation:** general solution, separation of variable, particle in a rectangular box, in a circle box, hydrogen atom, vibrating string, normal modes of vibration. (3 L) **Polynomials in quantum chemistry:** The Legendre equation, Legendre polynomials, associated Legendre polynomial, orthogonality and normalization, Hermite equation, Hermite Polynomials. Laguerre equation, associated Laguerre functions, spherical harmonics. (3L) **Function in three dimension:**Spherical polar coordinates, atomic orbitals, volume integrals, density functions, etc. (2 L)
Text Books, and/or reference material	1. Quantum Chemistry: A Molecular approach by Donald A. McQuarrie 2. Introductory quantum chemistry by A. K. Chandra 3. Molecular Quantum Mechanics By Atkins and Friedman, Oxford 4. Quantum Chemistry by Ira L. Levine

Mapping of COs (Course Outcomes) and POs (Programme Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	3	2	2	2	3	3	2	2	1	1
CO2	3	2	3	2	2	2	3	3	2	2	1	1
CO3	3	2	3	2	2	2	3	3	2	2	1	1
CO4	3	3	3	2	2	3	3	3	2	3	1	1
CO5	3	3	3	2	2	3	3	3	2	3	1	1

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CYC702	**Inorganic Reaction Mechanisms and Magnetochemistry**	PCR	3	1	0	4	4
Pre-requisites		Course Assessment methods [Continuous (CA), mid-term (MT) and end Term (ET)]					
NIL		CA+MT+EA					
Course Outcomes	**CO1**: Basic concept of inorganic reaction mechanism associated with octahedral and square planar complexes. **CO2**: Types of electron transfer reactions of the complexes including the detail mechanism **CO3**: Solving the problems related to Marcus theory. **CO4**: Types of magnetic substances and their magnetic properties.						

	CO5: Quantum numbers and origin of magnetic moments; microstates and derivation of Russel-Saunders Terms for various electronic configuration, Lande Interval Rule, Hole formalism and equivalency. **CO6**: Determination methods of magnetic susceptibility of various metal complexes, multiplet widths and derivation of various equations to determine magnetic moments, orbital magnetic moment quenching, concept of high-, low-, intermediate- and admixed-spin state and their interactions.
Topics Covered	Stoichiometric mechanism, second order limiting rate constant, base hydrolysis, Effects of non-leaving ligands, proton exchange, activation parameters.(5 L) Stereochemistry of octahedral substitution reactions, racemisation reaction (Bailar twist and Ray –Dutt twist) (4L) Square planar complexes: Ligands substitution reactions, General features, significance of rate law, effect of entering and leaving ligands, The trans effect, theories of trans effect, grounds state effects, transition effect, steric effects of non-leaving ligands, catalysis of substitution by redox process. (4L) Electron transfer reaction: Types of electron transfer reaction, outer sphere electron transfer process: electron transfer and reorganisation and chemical activation, potential energy diagram, Marcus theory for outer sphere cross reaction. (5L) Inner sphere electron transfer process: steps, rate law, types of inner sphere electron transfer process, bridging ligand, remote attack, the chemical mechanism. (4L) Definition of magnetic properties, types of magnetic bodies, sources of paramagnetism: orbital and spin effects, Diamagnetism and Pascal's constant, diamagnetic correction of ligands and metal complexes.(3 L) Quantum numbers and vectors, Mutual inclination of electron orbits and resultant vectors, Russel-Saunders coupling and j-j coupling, Ground State Term Symbol and Hund's rules. (2L) Microstates and derivation of Russel-Saunders Terms for p^2, d^2 and pd configuration, Spin-orbit interaction (2L) Lande Interval Rule, Hole formalism and equivalency, Hund's third rule and energies of J levels, Russel-Saunders coupling of d2 system and j-j coupling (3L) Thermal energy and magnetic property, Magnetic moments for different multiplet widths i.e for multiplet width large compared to KT, small compared to KT and comparable to KT (3L) Magnetic properties of Lanthanides, first transition series metal ions and actinides. (2L) Determination of magnetic susceptibility: Gouy's method, Faraday's method, NMR method and their advantage and disadvantages, magnetic anisotropy. (3L) Magnetic properties of complexes with different geometries based on crystal field model, spin-state equilibrium in octahedral stereochemistry, magnetic properties of high-spin, low-spin, intermediate-spin and admixed-spin state concept. (2L) Quenching of Orbital magnetic moment by crystal field, loss of orbital degeneracy and quenching of orbital magnetic moment, valence bond and crystal field interpretation of magnetic moment, shortcomings of crystal field theory. (2L)
Text Books, and/or reference material	1. Inorganic chemistry, Shriver & Atkins, Oxford. 2. Concept and models of inorganic Chemistry, Douglas, Mcdeniel, Alexander, Wiley. 3. Inorganic Chemistry, Huheey, Kieter, kieter, Medhi, Pearson education 4. Concise Inorganic chemistry, Lee, Wiley IndiaPvt. Ltd 5. Elements of magnetochemistry by Dutta & Shyamal 6. Mechanisms of Inorganic Reactions by Fred Basolo and Ralph Pearson

CURRICULUM AND SYLLABUS FOR INTEGRATED MSC IN CHEMISTRY

Mapping of COs (Course Outcomes) and POs (Programme Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	3	3	1	1	1	3	3	1	1	1
CO2	3	1	3	3	1	1	1	3	1	1	1	1
CO3	3	1	3	3	1	1	1	3	1	1	1	1
CO4	3	2	3	2	2	1	3	3	3	3	1	1
CO5	3	2	3	3	2	1	3	3	3	3	1	1
CO6	3	2	3	3	2	3	3	3	3	3	1	1

Course Code	Title ofthecourse	Program Core(PCR)/ Electives(PEL)	TotalNumberofcontacthours				Credit
			Lecture(L)	Tutorial(T)	Practical(P)	TotalHours	
CYC703	**ConceptofOrganicSynthesisandAsymmetricSynthesis**	PCR	3	1	0	4	4

Pre-requisites	CourseAssessmentmethods[Continuous assessment(CA),mid-term test (MT) and end term test (ET)]
None	CA+MT+ET

CourseOutcomes	**CO1**: A complete knowledge on tactics, strategy and control for the synthesis oforganic compounds has been elaborately discussed using some specific reagentsfor particularcompoundsynthesis. **CO2**: How the better yield of product could be obtained, their tactics, strategyandcontrolhas beenhighlighted. **CO3**: Role of specific reagents with related mechanism in their transformationand mechanistic path from substrate to products is included for their step bystepreactions. **CO4**: Uses of specific reagents for stereo control reaction in asymmetric synthesis **CO5**: Uses of proper solvent for organic syntheses, purification and separation
TopicsCovered	PlanningOrganicSyntheses: 1. Tactics, Strategy and Control; Selectivity: chemoselectivity, regioselectivity,stereoselectivity: (2L) 2. Making Carbon-carbon single and double bonds: Enolates, homoenolates,extendedenolates, nitrogen analogues of enols and enolates, acyl anionequivalents, allyl anions, specific enol equivalents, Michael reaction, σ-complexesofmetals,orgnometallicreagents,aldoladditionandcondensation reactions, Mukaiyama aldol condensation, control of facialreactivity,ClaisenandDieckmanncondensation,conjugateaddition,ortho-strategy for aromatic compounds, Palladiumcatalysedcoupling reactions. Olefinationreactions– Wittigandrelatedreactions,Juliaolefination.Sulfenylationandselenenylation,hydroalumination,carboalumination,ROMPandRCMP. (8L) 3. Functional group interconversion and Retro-synthetic analysis: Synthonesand synthetic equivalents, functional group interconversions and order ofeventsinorganicsynthesis.Onegroup-C-XandtwogroupsC-Xdisconnections,chemoselectivity,reversalofpolarity,cyclisationreactions,aminesynthesis.OnegroupC–CandtwogroupC–Cdisconnections (typical examples), use of acetylenes and aliphatic nitrocompoundsinorganicsynthesis.Diels-Alderreactions,1,3-and1,5-difunctionalisedcompounds,α,β-unsaturatedcarbonylcompounds,controlincarbonylcondensation,MichaeladditionandRobi

	nsonannulation. Ring synthesis: saturated heterocycles synthesis of 3-, 4-, 5-,and6-membered rings,aromaticheterocyclesinorganicsynthesis. (8L) 4. Classic total synthesis of some natural products: Strategies and synthesisof some classic examples of total synthesis; L-hexoses, Prostaglandines, Longifolene, penicillin, Periplanone etc. (10L) 5. Asymmetricsynthesis:Controlofstereochemistry,chiralpool,asymmetric induction via reagents and catalysts, kineticresolution,Synthesis of enantiometricallypurecompounds.(8L)
Text Books,and/orreferencematerial	1. OrganicChemistrybyJ.Clayden,N.Greeves,S.Warren&P.Wothers,OxfordUniversityPress,2001 2. Organicsynthesisstrategyandcontrolby P.Wyatt&S.Warren,Wiley,2007. 3. AdvancedOrganicChemistrybyF.A.Carey&R.J.Sundberg,Springer,2007. 4. Principles of Organic Synthesis, R.O.C. Norman & J.M. Coxon, Nelson Thrones,1993,CRCPress. 5. OrganicsynthesisbyM.Smith,Elevier,4thEdition,2016. 6. ClassicsinTotalSynthesis:Targets,strategiesandMethodsbyK.C.Nicolaou&E.J. Sorensen,Wiley,1996. 7. ModernMethodsinOrganicSynthesisbyW.Carruthers,CambridgeUniversityPress,2004. 8. ProtectiveGroupsinOrganicSynthesisbyT.W.Green&P.G.M.Wuts,Wiley,2002.

Mapping of COs (Course Outcomes) and POs (Programme Outcomes)

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	3	2	3	2	3	3	3	1	3	2
CO2	3	3	2	3	2	2	3	2	3	3	1	2
CO3	3	2	3	2	1	3	2	3	2	2	1	2
CO4	3	3	2	3	2	1	3	2	1	2	2	2
CO5	2	2	2	1	3	2	2	1	2	2	1	3

CourseCode	Titleof thecourse	ProgramCore(PCR)/ Electives(PEL)	TotalNumberof contacthours				Credit
			Lecture(L)	Tutorial(T)	Practical(P)	TotalHours	
CYS751	**SpectrophotochemicalAnalysis**	PCR(Practical)	0	0	3	3	2

Pre-requisites	Course Assessment methods: [Continuous evaluation (CE) and end assessment (EA)]
NIL	CE+EA

CourseOutcomes	**CO1**:Basicconceptsofspectrophotometric estimation **CO2**:Learningabouthandlingofspectrophotometerandfluorescencespectrometerand theirbasic theory. **CO3**:Todeveloplaboratoryskillsandtheabilitytoworkindependentlyaswellasin a group.

	CO4:Knowingpresentation,analysisandinterpretationofdata,sourceoferroranderror analysis. **CO5**: To understand the interconnection betweenexperimental foundationandunderlyingtheoretical principles. **CO6**:Todeveloptheabilityofscientificcommunicationsthroughoralquizzes,writtenreportsa ndpresentations
TopicsCover ed	• DeterminationofstoichiometryofFerricsalicylicacidcomplexbyJob's method • Determinationofindicatorconstantofmethylorange • DeterminationofconcentrationofCu^{2+}andFe^{3+}photometricallybytitratingwith EDTA • Determinationofarsenic(III)andantimony(IV)simultaneouslyina mixturespectrophotometrically. • Determinationofmolarextinctioncoefficient • Determinationoffluorescencequantumyield. • Fluorescencequenchingexperiment:determinationofmicellaraggregationnumber. Someadditional experimentsas decidedbythe Instructor.
TextBooks, and/orrefer encemateri al	1. InstructionmanualprovidedbytheInstructor 2. ExperimentsinPhysicalChemistrybyCarlGarland,JosephNibler,DavidShoemaker 3. Practicalsin PhysicalChemistrybyPS Sindhu 4. PracticalPhysicalChemistrybyViswanathan andRaghavan

Mapping of COs (Course Outcomes) and POs (Programme Outcomes)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	2				1			1	1	2
CO2	3	3		2	2	3	1	2	2	1	1	2
CO3	3	1				2	1	2	2	1	3	2
CO4	3	1					1			1	1	2
CO5	3	1					1			1	1	2
CO6	3	1					1			1	1	2

Course Code	Title of the course	Program Core (PCR)/ Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CYS752	**Spectrophotometric Estimation of Cations and Anions**	PCR (Practical)	0	0	3	3	2
Pre-requisites		Course Assessment methods: [Continuous evaluation (CE) and end assessment (EA)]					
NIL		CE+EA					
Course Outcomes (The students will master the		**CO1**: Basic concepts of spectrophotometric estimation **CO2**: Understand to evaluate the estimation of ion mixture **CO3**: Learning about handling of spectrophotometer **CO4**: Understand the fundamental, scientific basis, preparation of sample,					

following)	sampling method and analytical methods for water and waste water samples. **CO5**: Students will also accumulate idea about the permissible limit, present concentration etc. of different environmental impurities.
Topics Covered	Estimation of MnO_4^- –$Cr_2O_7^{2-}$ mixture Estimation of NO_3^- –PO_4^{3-} mixture Estimation of NO_3^- –PO_4^{3-} mixture Estimation of Ti^{+4}–V^{+5} mixture Estimation of dissolved oxygen and oxygen demand (BOD and COD) of Environmental Samples. Some more experiments from the followings as decided by the Instructor. (i) Determination of Ni in steel (Gravimetrically) (ii) Analysis of Brass and Aluminum in Bronze (iii) Spectroscopic determination of Iron in Bauxite
Text Books, and/or reference material	1. An Advanced Course in Practical Chemistry by Nad, Ghosal and Mohapatra, New Central Book agency. 2. A Manual of Practical Chemistry for Degree Classes (Vol I & II) by R. C. Bhattacharya, 3. College Practical chemistry by Ahluwalia, Dingra and Gulati. 4. Vogels textbook of quantitative chemical analysis By J Mendham, R. C. Denney, M. Thomas and D. J. Barnes, Pearson India. 5. APHA, A, WEF, (1998). Standard Methods for the Examination of Water and Wastewater. American Public Health Association, American Water Works Association,Water Pollution Control Federation, Washington DC.

Mapping of COs (Course Outcomes) and POs (Programme Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	3	3	3		3	2	1	1	
CO2	3	2	1	2	1	2	1	3	2	2	1	1
CO3	3	2	3	2		3	3	3	2	2	1	
CO4	3	3	3	3	3	2	1	3	3	3	2	3
CO5	3	2	3	2	3	2	1	3	3	3	3	3

Course code	Title of the course	Program Core (PCR)/Electives (PEL)	Total number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total hours	
CYS753	**Identification of Organic Compounds from Binary Mixture**	PCR (Practical)	0	0	4	4	2
Pre-requisites		Course Assessment methods: [Continuous evaluation (CE) and end assessment (EA)]					
CYS351		CE+EA					
Course outcomes	**CO1**: To know the principles of separation techniques to reach a targeted pure separate component from a binary mixture. **CO2**: To become skilled to optimise the uses of solvent obeying the principle of green chemistry. **CO3**: To know various separation and purification techniques, like phase transfer,						

	crystallization, GC-Mass etc. **CO4**: To understand the basic concept behind separation process for most common different methodology and their principles like; distillation, sublimation, crystallization etc. **CO5**: To reach a maximum yield with minimum uses of solvent, reagents and energy like; heat and electricity (Green chemistry).
Topics covered	1. Aniline and benzil (Liquid and solid) 2. Ethyl acetoacetate and benzoic acid (Liquid and solid) 3. Benzil and benzoic acid (solid and solid) 4. p-Chlorobenzoic acid and aniline (solid and liquid) 5. Cyclohexanone/cyclohexanol and N,N-dimethylaniline (liquid and liquid) In each case, separation and identification of individual components, preparation of derivatives of each component, their purification and characterization shall be performed.
Text Books, and/or reference materials	1. Vogel's Textbook of practical organic chemistry, 5th Edition 2. Advanced practical chemistry, 3rd Edition by S. C. Das 3. An Advanced Course in Practical Chemistry, 3rd Edition by A. K. Nad, B. Mahapatra & A. Ghoshal

Mapping of COs (Course Outcomes) and POs (Programme Outcomes)

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	3	2	2	2	1	3	2	2	3	3
CO2	3	3	2	2	2	2	2	3	2	2	3	3
CO3	3	2	3	2	2	2	2	2	2	2	3	3
CO4	3	2	3	2	3	3	1	3	2	3	3	3
CO5	3	3	2	2	3	3	2	3	2	3	3	3

EIGHTH SEMESTER

Course Code	Titleof thecourse	ProgramCore(PCR) /Electives(PEL)	TotalNumberof contacthours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CYC801	**Chemical,Statistical Thermodynamicsand dElectrochemistry**	PCR	3	1	0	4	4
Pre-requisites		Course Assessment methods [Continuous assessment (CA), mid-term (MT) and end term (ET)]					
NIL		CA+MT+ET					

CourseOutcomes	**CO1**:To understand the thermodynamics ofideal,non-ideal and multicomponentsystems. **CO2**: To understand the concept ofentropy of a system at absolute zero and itsimplication. **CO3**: To account for physical interpretation of partition functions and able to analyzethermodynamic properties of model systems with using Boltzmann, Fermi-DiracandBose-Einstein statistics. **CO4**:To understandtheionicpropertiesinsolution,likediffusion,migration,conductionand theirinterrelation. **CO5**:To accountfor fundamental ideasofDebye-Huckeltheoryanditsapplication.
Topics Covered	**Third law of thermodynamics:** Thirdlawofclassicalthermodynamicsandtheirapplications. (2L) **Thermodynamics of non-ideal solution:** Thermodynamicsofidealandnon-idealbinarysolutions:freeenergyandentropyofmixing,partialmolarquantitiesandtheirdetermination,fugacityandits determination. (4L) Gibbs-Duhemequation,Duhem-Margulesequation,equilibriumconstant,temperaturedependent equilibrium constant. (3L) Thermodynamicexcessfunctions.Experimentaldeterminationofactivitycoefficientofelectrolytes andnon-electrolytes. (3L) **StatisticalThermodynamics:** Introductiontostatisticalthermodynamics,probability,ensemblesanddistributionlaws, partition function. (5L) Maxwell-Boltzmann Statistics, Translational, Rotational, Vibrational, Electronic, Nuclear partition function of mono,diatomicandpolyatomic ideal gas and their thermodynamic properties including Gibb's paradox, Sacur-Tetrode Equation. Heat Capacity of solids: Dulong Petit, Einstein, Debye law. Concept of residual entropy. (12L) Onset of Quantum Statistics, Indistinguishability inbuilt in quantum mechanics,Fermi-DiracandBose-EinsteinStatistics and classical limit of quantum statistics. (4L) Chemicalequilibrium, Transitionstatetheoryusing partitionfunctions. (3L) **Electrochemistry:** Somepreliminaryconceptofelectrostatics. (3L) Ion-solventinteraction:Bornequation,Electrostrictionandpartialmolarvolume. Solvation number of electrolytes. Dielectric constant of solution.Effectofnonelectrolyte onion-

	solventinteraction.Ion-dipoleinteraction. (4L) Ion-ion interaction: Debye-Huckel-Onsagar theory of inter-ionic interaction,thicknessof ionicatmosphere.Debye-Huckel limitinglaw. (4L) Ion transport in solution: Fick's first and second law of diffusion, Molecularinterpretation of diffusion, Migration of ion under electric field, Effect ofviscosity and diffusion on ionic migration. Relaxation of ionic atmosphere,Effectof highelectricfield and highfrequencyofionicconduction. (4L) Rate processapproachtowards ionicmigration:Nernst-PlanckFluxequationanditsapplication. (3L) Transportofionthroughmembrane:Donanequilibrium. (2L)
TextBooks, and/orreferencematerial	1. Modernelectrochemistry:Ionics(Part1);andElectrodics(Part2)byBockrisand Reddy 2. AnintroductiontostatisticalthermodynamicsbyT.L.Hill 3. PhysicalChemistry:StatisticalMechanicsbyH. Metiu(TaylorandFrancis) 4. PhysicalChemistry:ThermodynamicsbyH.Metiu(Taylorand Francis) 5. ChemicalThermodynamics:PrinciplesandApplications;andAdvancedApplicationsby Ott andGoates

Mapping of COs (Course Outcomes) and POs (Programme Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	2	-	2	3	3	2	2	1	1
CO2	3	-	-	2	-	2	3	3	2	2	1	1
CO3	3	-	2	2	-	2	3	3	2	2	1	1
CO4	3	3	3	2	2	3	3	3	2	3	1	1
CO5	3	-	-	3	1	-	-	-	-	-	-	-

Course Code	Title of the course	Program Core (PCR)/ Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CYC802	**Organometallic Compounds and Bioinorganic Chemistry**	PCR	3	1	0	4	4
Pre-requisites		Course Assessment methods [Continuous assessment (CA), mid-term (MT) and end term (ET)]					
NIL		CA+MT+ET					
Course Outcomes	**CO1**: Knowledge of s, p and d block organometallics in respect of synthesis, structure and bonding in different ligand environment. **CO2**: Knowledge of different types of reactions of organometallics compounds and their role in different catalytic cycles related to industrial processes. **CO3**: Understanding the role of trace elements in health and environment, chemistry of metal cytotoxicity and its remedy. **CO4**: Knowledge the structure and function of metalloenzymes and metalloproteins with special emphasis of iron storage, oxygen transport and photosynthesis. **CO5**: Application of modern spectroscopic tools to elucidate the active sites of metalloenzymes and metalloproteins.						

Topics Covered	Gr. I and Gr. II organometallics: synthesis, properties and application. (2 L) d –metal organometallics: History, stable electronic configuration, 18 and 16 electronic system, electron count and oxidation state, Nomenclature, π-acid ligands and low oxidation states.(3 L) Metal carbonyl: Binary carbonyl: synthesis, bonding, spectroscopic characterisation of carbonyl compounds. (4 L) Substituted carbonyl: phosphine, isocyanide, nitrosyl, dinitrogen, carbenes, hydrides, and dihydrogen, η1 alkyl, alkenyl, alkynyl, aryl, η2 alkene, alkyne, non-conjugateddiene, , butadiene, cyclobutadiene, cyclotetracene, allylligand, cyclopentadiene, and cycloheptatriene, Metallocenes: synthesis, reactivity and bonding of ferrocene etc. (6 L) Reactions: ligand substitution oxidative addition and reductive elimination, σ-bond metathesis, 1,1 migratory insertion, 1,2 insertion, β-hydride elimination, Homogeneous catalysis: hydrogenation catalyst, hydro formylation, Wacker oxidation of alkenes,asymmetric oxidation, metathesis.(5 L) Cage and metal clusters.(3 L) Bio-inorganic: Occurrence and availability of inorganic elements in organisms; essential, beneficial and trace elements, Synergistic and antagonistic relationship of metal ions, Element deficiency and toxicity, Metal poisoning detoxification.(1 L) Biological ligands for metal ions: Nucleobases, nucleotides and nucleic acids (DNA, RNA) as ligands, tetrapyrrole ligands and other macrocycles (chlorin, corrin), Concept of protein structures: primary, secondary, tertiary and quaternary; Coordination of proteins and comments on enzymatic catalysis.(1 L) Cobalamins including vitamin and Coenzyme B12: History and structural characterisation; Reactions of the alkylcobalamins (a) One-electron reduction and oxidation, (b) Co-C bond cleavage, (c) Mutase activity of Coenzyme B12 and (d) alkylation reactions of Methylcobalamins; Model systems and the role of the Apoenzyme.(3 L) Metals at the center of photosynthesis: Total efficiency of photosynthesis; Primary processes in photosynthesis such as (a) Light absorption, (b) Exciton Transport, (c) Charge separation and electron transport (Photosystem-I, Photosystem-II, Z-Scheme); Manganese catalysed oxidation of H_2O to O_2(4 L) The dioxygen molecule, O_2 Uptake, transport and storage: Molecular and chemical properties of O_2, Oxygen transport and storage through Haemoglobin and Myoglobin, Alternative oxygen transport by some lower animals by Hemerythrin and Hemocyanin, Active site structure elucidation using magnetism, light absorption, vibrational spectroscopy and Mössbauer spectroscopy. (4 L) Uptake, transport and storage of an essential elements as exemplified by Iron: Iron mobilization problem-----Oxidation states, solubility and medical relevance; Siderophores (Fe uptake by microorganism), Phytosiderophores (Fe uptake by plants), Transport and storage of iron (Transferrin, Ferritin, Hemosiderin).(4 L) Copper containing proteins as an alternative to biological iron: Type 1 blue copper center, Type 2 and Type 3 copper centers in O_2 activating proteins, Copper proteins as Oxidases/Reductases, Cytochrome c Oxidase, Cu-Zn and Ni superoxide dismutases (4 L)

Text Books, and/or reference material	1.	Concept and models of inorganic Chemistry, Douglas, Mcdeniel, Alexander,
	2.	Inorganic chemistry, Shriver & Atkins, Oxford
	3.	Inorganic Chemistry, Huheey, Kieter, kieter, Medhi, Pearson education.
	4.	The Organometallic Chemistry of the Tr. Metals by Robert H. Carbtree.
	5.	Bioinorganic chemistry by Bertini, Gray, Lippard and Valentine.

Mapping of COs (Course Outcomes) and POs (Programme Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	3	3	2	2	2	3	3	2	1	1
CO2	2	2	3	2	2	2	2	3	3	1	1	1
CO3	2	3	3	2	2	2	2	3	3	3	1	1
CO4	3	3	3	1	2	2	3	3	3	3	1	1
CO5	3	3	3	1	1	3	3	3	3	2	1	1

Course code	Title of the course	Program Core (PCR)/Electives (PEL)	Total number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total hours	
CYC803	**Pericyclic Reactions and Organic Photochemistry**	PCR	3	1	0	4	4
Pre-requisites		Course Assessment methods [Continuous assessment (CA), mid-term (MT) and end term (ET)]					
NIL		CA+MT+ET					
Course outcomes	**CO1**: To understand the basic principles of pericyclic and their classifications **CO2**: To apply the concepts of pericyclic reactions in organic synthesis **CO3**: To understand the basic principles of organic photochemical reactions and their classifications **CO4**: To learn the concepts of photoredox catalysis **CO5**: To apply the concepts of organic photochemistry in organic synthesis **CO6**: To analyse the probable mechanism of pericyclic and organic photochemical reactions						
Topics covered	**Pericyclic reactions:** **18 L** Molecular orbital symmetry, Frontier orbitals of ethylene, 1,3-butadiene, 1,3,5-hexatriene and allyl system. (3 L) Classification of pericyclic reactions. Woodward-Hoffmann correlation diagrams. FMO & PMO approach. (3 L) Electrocyclic reactions - conrotatory and disrotatory motions. 4n, 4n+2 systems. (4 L) Cycloaddition – antarafacial and suprafcial additions, 4n and 4n+2 systems, 2+2 addition of ketenes, 1,3 dipolar cycloadditions and cheletropic reactions.(4 L) Sigmatropic rearrangements - suprafacial and antarafacial shifts of H, Sigmatropic shifts involving carbon moieties, 3,3- and 5,5 sigmatropic rearrangements. Claisen, cope and aza-cope carbon rearrangements. Fluxional tautomerism, Ene reactions.Recent advances from current literature. (4 L) **Organic photochemistry:** **18 L** General information, Photo-chemical energy, effect of light intensity on the rate of photochemical reactions. Jablonski-diagram, photo-sensitisation and quenching. Norrish type-I, type-II processes, Paterno-Buchi reaction, photochemistry of unsaturated						

	compounds. (4 L) Types of photochemical reactions: Photo-dissociation, gas phase photolysis. Photochemistry of alkenes: Intramolecular reactions of the olefinic bond-geometrical isomerism, cyclisation reactions, rearrangement of 1,4- and 1,5-dienes. (3 L) Photochemistry of Carbonyl compounds: Intramolecular reactions of carbonyl compounds saturated, cyclic and acyclic, β,γ-unsaturated and α,β-unsaturated compounds. Cyclohexadienones, Intermolecular cycloaddition reactions, dimerization and oxetane formation. (4 L) Aromatic compounds: Isomerisation, additions and substitutions. Miscellaneous photochemical reactions: Photo-Fries reactions of anilides, Photo-Fries rearrangement, Barton reaction, Singlet molecular oxygen reactions. (2 L) Photo-degradation of polymers, photo-substitution, photo-reduction of ketones, photo-oxidation, di-π methane rearrangement, photochemistry of arenes. (3 L) Organo-metallic photochemistry, photochemistry of vision. (2 L)
Text Books, and/or reference materials	1. Molecular Orbitals and Organic Chemical Reactions by I. Fleming, Wiley. 2. Pericyclic reaction by S. Sankararaman, Wiley VCH, 2005. 3. Photochemistry and Pericyclic Reactions by Jagdamba Singh, New Age Science publisher 4. Mechanism of Organic Chemistry by Peter Sykes

Mapping of COs (Course Outcomes) and POs (Programme Outcomes)

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	2	2	1	3	2	1	2	2
CO2	3	3	3	3	2	2	1	3	2	2	2	3
CO3	3	3	3	2	2	2	1	3	2	1	2	2
CO4	3	3	3	2	2	2	1	3	3	2	2	3
CO5	3	3	3	3	2	3	2	3	3	1	2	3
CO6	3	3	3	3	2	3	2	3	3	1	2	2

CourseCode	Titleofthecourse	ProgramCore(PCR)/ Electives(PEL)	TotalNumberof contacthours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CYC804	**Spectroscopy: Theory and Applications**	PCR	3	1	0	4	4
Pre-requisites		Course Assessment methods [Continuous assessment (CA), mid-term (MT) and end term (ET)]					
NIL		CA+MT+ET					
CourseOutcomes	**CO1**: Understanding the principle and applications of UV-VIS, IR and Raman spectroscopy to elucidate the structure of different organic and inorganic molecules. **CO2**: Understand the core concept of Mass Spectroscopic techniques and their contribution to the methods of structure elucidation of organic and inorganic species. **CO3**:Understand the different aspect of Nuclear Magnetic Resonance spectroscopy and its application in the field of structure determination of organic and inorganic						

	species
TopicsCovered	1. Theories of Microwave, IR, UV-VIS and Raman spectroscopy and their applications to elucidate the structure of different organic and inorganic molecules. Broadening of spectral lines. Basics of Furrier transform technique. Details of the instrumentation used for these spectroscopic techniques. (18 L) 2. **Mössbauer Spectroscopy:** Basic principles, spectral parameters and spectrum display. Application of the technique to the studies of (i) bonding and structures of Fe(II), Fe(III) compounds and (ii) detection of oxidation states. (4 L) 3. **NMR Spectroscopy**: Basic principles, chemical shift, spin-spin interactions andcoupling constants, Interpretation of first order NMR spectra; methods forsimplification of second order spectra: use of double resonance, Lanthanide shiftreagent, spin-tickling, INDOR, NOE, effect of solvents, preliminary idea on ^{19}F, ^{31}P, ^{14}N, ^{15}N, ^{17}O, NMR imaging, ^{13}C NMR Spectroscopy: Basic principles, proton decoupled spectra, interpretation and application in organic molecules. (14 L) 4. **Mass Spectrometry**: Basic principles, soft ionization methods: CI, FD, FAB, plasmadesorption; fragmentation pattern in EI, GC-MS, MS-MS, LC-MS. Application of MS instructure elucidation. (8 L)
Text Books, and/or reference materials	1. Fundamentals of molecular spectroscopy by Banwell 2. Elements of magnetochemistry: Dutta and Shyamal 3. Structural methods in molecular inorganic chemistry: Rankin, Mitzel, Mosrision 4. NMR spectroscopy (Basic Principles, concepts and application in chemistry): H. Gunther 5. Spectrometric identification of organic compounds: Robert Silverstein 6. Organic spectroscopy: William Kemp

Mapping of COs (Course Outcomes) and POs (Programme Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	2	2	1	3	3	2	2	1
CO2	3	3	3	3	3	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3	3	3	3	3	3

CURRICULUM AND SYLLABUS FOR INTEGRATED MSC IN CHEMISTRY

Course Code	Titleofthe course	ProgramCore (PCR) /Electives(PEL)	TotalNumberofcontacthours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CYE811	**Chemistry of materials: Synthesis, structure and applications**	PEL	3	0	0	3	3
Pre-requisites		Course Assessment methods [Continuous assessment (CA), mid-term (MT) and end term (ET)]					
NIL		CA+MT+ET					

Course Outcomes	**CO1**:To learn about the different methods of synthesis of materials. **CO2**: To understand the challenges involved in the synthesis processes of materials and how to overcome the challenges. **CO3**: To know about the characterization techniques employed for the characterization of materials. **CO4**: To have the concept of symmetry in materials (including point group and space group). **CO5**: To learn about amorphous and crystalline materials. **CO6**: To have a comprehensive idea about the structure and applications of materials.
Topics Covered	Synthesis of materials: high temperature ceramic techniques, solution combustion technique, sol-gel, inorganic metathesis route, hydrothermal techniques, pyrolysis, air sensitive synthesis, bulk materials and nano-materials, porous materials.(4 L) Concepts of Symmetry: point groups and space groups, crystal lattices, unit cell. (8 L) Methods of crystallography: powder, single crystals, X-ray, neutron and electron diffraction, amorphous and crystalline materials visualization and drawing of crystal structure. Miller indices, Miller-Bravis indices. (12 L) The reciprocal lattice, Brag's law in reciprocal lattice, crystal symmetry, point group and space group, data collection, Intensity of data collection, theory of structure factors, X-ray photoelectron spectroscopy (XPS). (8 L) Characterization of materials: different spectroscopy, diffraction, microscopy, adsorption and desorption, thermal analysis. (2 L) Electrical, Ionic, Magnetic, Optical, Properties and Applications. (2 L)
TextBooks, and/or reference material	• A.R. West, Solid State Chemistry and its applications. • L.E. Smart and Moore, Solid State Chemistry An Introduction. • C. Kittel, Introduction to solid state physics • C.N.R. Rao and J. Gopalakrishnan, New directions in solid state chemistry • C Giacavazzo (Ed.) Fundamentals of crystallography • J. D. Dunitz, X-ray analysis and the structure of organic moleculesG.H. Stout and L.H. Jensen, X-ray structure determination: A practical guide

CURRICULUM AND SYLLABUS FOR INTEGRATED MSC IN CHEMISTRY

Mapping of COs (Course Outcomes) and POs (Programme Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	2	3	3	3	3	3	3
CO2	3	3	3	3	3	3	2	3	1	2	3	3
CO3	3	3	3	3	2	3	3	2	3	2	2	3
CO4	3	3	3	3	3	2	3	3	2	3	3	3
CO5	3	3	3	3	3	3	3	1	3	3	3	3
CO6	3	3	3	3	3	3	3	3	3	3	2	3

CURRICULUM AND SYLLABUS FOR INTEGRATED MSC IN CHEMISTRY

<table>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Titleofthecourse</td><td rowspan="2">ProgramCore(PCR)/ Electives(PEL)</td><td colspan="4">TotalNumberof contacthours</td><td rowspan="2">Credit</td></tr>
<tr><td>Lecture (L)</td><td>Tutorial (T)</td><td>Practical (P)</td><td>Total Hours</td></tr>
<tr><td>CYE812</td><td>Molecular Modelling in Chemistry</td><td>PEL</td><td>3</td><td>0</td><td>0</td><td>3</td><td>3</td></tr>
<tr><td colspan="2">Pre-requisites</td><td colspan="6">Course Assessment methods [Continuous assessment (CA), mid-term (MT) and end term (ET)]</td></tr>
<tr><td colspan="2">CYC701</td><td colspan="6">CA+MT+ET</td></tr>
<tr><td>CourseOutcomes</td><td colspan="7">CO1: Apply the principles of quantum mechanics to understand molecular interactions, structure and chemical bonding.
CO2: Understanding of Potential energy surface
CO3: Apply DFT and ab initio techniques to determine molecular properties
CO4: Understanding reaction mechanism.
CO5: Modelling of large assembly of atoms/molecules using approximate molecular dynamic simulations and Monte Carlo methods.
CO6: Knowledge on commercially available DFT and molecular modelling software packages.</td></tr>
<tr><td>TopicsCovered</td><td colspan="7">Overview of molecular modelling:
Brief review of the basic principles of quantum mechanics of atoms and molecules. Concept of quantum mechanical ab initio calculations within Born-Oppenheimer approximation, density functional theory, semi-empirical and Molecular Mechanics calculations. (2L)
Potential Energy Surfaces:
Potential energy surfaces and intermolecular interactions and modelling of calculated energy by model potentials for simple atoms, ions and molecules. Concept of short range and long range interactions. (4L)
Basics of ab initio and DFT calculations:
Modelling of Single molecules: Geometry optimization, Vibrational frequency calculations, Conformational analysis etc. (2L)
Molecular Dynamics Simulations:
Study of an assembly of atoms or molecules (cluster and/or bulk phases). Approximation of the total potential energy as the sum of pair potentials. (4L)
Concept of large number of microstates, averages and basic principles of Monte Carlo and Molecular Dynamics simulations. (4L)
Flexible models and calculation of force constants. Structural and dielectric properties of a polar medium: Continuum models versus molecular models. Calculation of structure, energy and free energy through simulations using molecular models. (4L)
Concept of hydrophobic and hydrophilic interactions. Use of molecular modelling in drug design, bio-molecules like peptides, proteins, membranes etc. (2L)
Programming Techniques: Python programming, Bash scripting, introduction to High Performance Computing (HPC) environment. (2L)
Software Packages:
Gaussian 16, Gaussview 6, Materials Studio, Discovery Studio and other open source software like ORCA, LAMMPS, Gromacs, NAMD etc for demonstration. (6L)</td></tr>
<tr><td>Text Books, and/or</td><td colspan="7">• Modern Quantum Chemistry, by Attila Szabo and Neil S. Ostlund, Dover Publications</td></tr>
</table>

reference material	• Molecular Modelling: Principles and Applications by A.R. Leach, Longman (1996). • Molecular Modelling and Simulation by T. Schlick, Springer (2006). • Computer Simulation of Liquids, M. P. Allen & D. J. Tildesley, Clarendon Press • Density Functional Theory: A Practical Introduction, by David Sholl and Janice A Steckel, Wiley-Interscience (2009)

Mapping of COs (Course Outcomes) and POs (Programme Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	2	1	3	3	1	1	2	1
CO2	3	2	3	2	2	1	3	3	1	1	2	1
CO3	3	2	3	2	2	1	3	3	2	3	2	1
CO4	3	3	3	2	2	1	3	3	2	1	2	1
CO5	3	3	3	2	3	1	3	3	3	1	2	1
CO6	3	3	3	3	3	1	3	3	3	2	3	1

Course Code	Title of the course	Program Core (PCR)/Electives(PEL)	Total Number of contact hours				Credit
			Lecture(L)	Tutorial (T)	Practical (P)	TotalHours	
CYS851	**AdvancedPractical on PhysicalChemistry**	PCR	0	0	4	4	2
Pre-requisites		Course Assessment methods: [Continuous evaluation (CE) and end assessment (EA)]					
CYS751		CE+EA					
Course Outcomes	**CO1**: Basic concepts of spectrophotometric estimation and IR spectroscopy.Experimental knowledge on the influence of reaction parameters on the rate ofthereaction, and analysisthereon. **CO2**:LearningabouthandlingofspectrophotometerandIRspectrometerandtheirbasictheory.						
Topics Covered	1. DeterminationofisoelectricpHofgelatin. 2. Rateconstantofalkaline hydrolysisofcrystalviolet 3. Salteffectonthe rateof alkalinehydrolysisofcrystalviolet 4. Solventeffectonthe rateofalkalinehydrolysisofcrystalviolet 5. Micellareffectontherateofalkalinehydrolysisofcrystalviolet 6. IntermolecularhydrogenbondinginbenzylalcoholusingIRspectroscopy 7. Thermodynamicsofmicellization. 8. Determinationofactivationparameterofareaction. 9. Determinationofmean ionicactivitycoefficient of an electrolyte byemfmeasurement. 10. 10. Preparation and characterization of nanoparticle. 11. Determination of the Viscosity average molecular weight of a macromolecule.						

Text Books, and/or Reference material	1. Instruction manual provided by the Instructor 2. ExperimentsinPhysicalChemistrybyCarlGarland,JosephNibler,DavidShoemaker 3. Practicalin PhysicalChemistrybyP.S. Sindhu 4. PracticalPhysicalChemistrybyViswanathan andRaghavan

Mapping of COs (Course Outcomes) and POs (Programme Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	-	-	-	-	-	-	-	-	-
CO2	3	3	-	2	2	3	-	2	2	-	1	-
CO3	-	-	-	-	-	2	-	2	2	-	3	3
CO4	3	3	-	3	3	-	1	3	-	-	-	-
CO5	-	-	-	-	-	-	-	3	3	-	-	
CO6	-	-	-	-	-	-	-	3	3	-	2	2

Course Code	Title of the course	Program Core (PCR) /Electives (PEL)	Total Number of contact hours				Credit
			Lecture(L)	Tutorial (T)	Practical (P)	Total Hours	
CYS852	**Synthesis and Characterisation of Complex Compounds**	PCR	0	0	3	3	2
Pre-requisites		Course Assessment methods: [Continuous evaluation (CE) and end assessment (EA)]					
NIL		CE+EA					

Course Outcomes	**CO1**: Coordination complex synthesis maintaining molarity. **CO2**: Crystallization techniques to purify the synthesized materials. **CO3**: Decomposition and estimation of metal ion(s) using spectrophotometry. **CO4**: Characterization of synthesized materials using FTIR, UV-Vis and EPR spectroscopy and CHN analysis. **CO5**: Spectral data interpretation.
Topics Covered	Synthesis of (a) $[VO(acac)_2]$; (b) $[Co(NH_3)_5(N_3)]$; (c) $[Mn(acac)_3]$; (d) $(NH_4)_2[MnF_5]$; (e) Mohr's salt and other complexes and their characterization using various spectroscopic methods. Estimation of metal ion of suitable complexes.
Text Books, and/or Reference material	1. Advanced Inorganic Experiments, By G. N. Mukherjee.

Mapping of COs (Course Outcomes) and POs (Programme Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	3	3	3	2	2	1	3	3	3	1	1

CO2	2	2	3	3	2	1	1	3	3	3	1	1
CO3	1	3	3	3	2	2	1	3	3	3	1	1
CO4	3	3	3	3	2	2	1	3	3	3	1	1
CO5	3	2	3	3	2	3	1	3	3	3	1	1

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CYS853	**Chromatographic Separation of Organic Compounds**	PCR	0	0	3	3	2

Pre-requisites	Course Assessment methods: [Continuous evaluation (CE) and end assessment (EA)]
NIL	CE+EA

Course Outcomes	**CO1**: Understand the working principles of different types of chromatography. **CO2**: Learn the sampling method including derivatization for analysis **CO3**: Master the techniques and application of thin layer, paper and column chromatography **CO4**: Learn to analyze the chromatograms of GC and HPLC
Topics Covered	**Thin Layer Chromatography** Determination of R_f values and identification of organic compounds. Preparation and separation of DNP derivatives of carbonyl compounds Separation of a mixture of dyes using cyclohexane and ethyl acetate (8.5:1.5). **Paper Chromatography: Ascending and Circular** Determination of R_f values and identification of organic compounds. Separation of a mixture of amino acids Separation of sugars **Column Chromatography:** Separation of Fluorescein and methylene blue Separation of aniline and *N,N* dimethyl aniline Separation of Lycopene and β-carotene **Demonstration of chromatographic separation by GC & HPLC**.
Text Books, and/or reference material	1. Fundamentals of analytical chemistry, Skoog, West, Holler and Crouch, 8th edition,Thomson

Mapping of COs (Course Outcomes) and POs (Programme Outcomes)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	3	3	3	1	3	3	3	3	3
CO2	2	3	3	3	3	3	1	3	3	3	3	3
CO3	1	3	3	3	3	3	1	3	3	3	3	3
CO4	3	3	3	3	3	3	3	3	3	3	3	3

CURRICULUM AND SYLLABUS FOR INTEGRATED MSC IN CHEMISTRY

NINTH SEMESTER

Course Code	Title of the course	Program Core (PCR)/ Electives(PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CYE911	**Advanced Quantumand Computational Chemistry**	PEL	3	0	0	3	3
Pre-requisites		Course Assessment methods [Continuous assessment (CA), mid-term (MT) and end term (ET)]					
CYC701		CA+MT+ET					

Course Outcomes	**CO1**: To apply different time dependent and time independent approximation methods to solve various molecular problems **CO2**: To apply Born-Oppenheimer approximation to separate nuclear and electronic components from molecular Hamiltonian. **CO3**: To analyze the chemical bonding through MO and VB theory **CO4**: To understand the interaction of radiation with matter and selection rules for transition among different molecular energy levels. **CO5**: To apply Hückel theory in conjugated system and it applications **CO6**: To evaluate the structure, spectroscopy, chemical bonding of small molecules using computational chemistry
TopicsCovered	**Approximate Methods:** The variation method, trial wave functions, introduction to perturbation theory, application to simple problems (Zeeman, Stark effect etc.) (7L) **Many Electron Atoms:** Classical Calculations of He atom, Hartree-Fock equations of Helium atoms, anti-symmetry in electron wavefunction, Slater determinants, Hartree-Fock-Roothan method (5L) **Spin-orbital interaction:** LS and JJ coupling, Term symbol and spectroscopic states. (2L) **Molecules and chemical bonding:** Born-Oppenheimer approximation, MO treatment of diatomic molecules, Idea of self- consistent field method, molecular electronic configurations. (4L) **Time dependent perturbation theory**: Transition dipole moment. Fermi's Golden rule. Lamberts Beers law, Einstein's coefficients for induced and spontaneous emission. (5L) **Hückel theory of conjugated systems:** Bond order and charge density calculations. Applications to ethylene, butadiene, cyclopropenyl radical, cyclobutadiene. (3L) **Software Demonstration ofHF and DFT calculations:** Modelling of Single molecules: Geometry optimization, Vibrational frequency calculations, time-dependent DFT calculations, NMR shift, Conformational analysis etc. (4L)

	Gas phase reactions through DFT calculation: Reaction mechanism through analysis of transition states, determination of activation energy, rate coefficients etc.(2L)
Text Books, and/or reference material	1. Quantum Chemistry by Levine 2. Physical Chemistry: A Molecular approach by Donald A. McQuarrie 3. 3.Introductory quantum chemistry by A. K. Chandra 4. Molecular theory and group theory by R. L. Carter

Mapping of COs (Course Outcomes) and POs (Programme Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	3	3	3	1	3	3	3	2	1	1
CO2	3	1	3	3	3	1	3	3	3	2	1	1
CO3	3	1	3	3	3	1	3	3	3	2	1	1
CO4	3	1	3	3	3	1	3	3	3	2	1	1
CO5	3	3	2	3	2	1	3	3	2	1	2	3
CO6	3	3	2	3	2	1	3	3	2	1	2	3

Course Code	Titleof thecourse	ProgramCore (PCR)/Electives(PEL)	TotalNumberof contacthours			
			Lecture (L)	Tutorial (T)	Practical (P)	TotalHours
CYE912	**Basics of Nonlinear Dynamics**	PEL	3	0	0	3
Pre-requisites		Course Assessment methods (Continuous assessment (CA), mid-term (MT) and end test (ET))				
CYC801		CA+MT+ET				
CourseOutcomes	**CO1**: The complexities of dealing Nonlinear systems compared to linear systems. **CO2**: The fundamentals of dynamical system theory such as stability, bifurcation etc. **CO3**: Numerical programing methods and approximate analytical techniques for various nonlinear problems. **CO4**: The application and usefulness of nonlinear dynamical theory in multi-disciplinary fields.					
TopicsCovered	**Introduction:** Motivation, scope, dynamical view, importance and application with examples of nonlinear dynamical systems. Autonomous and Non-autonomous dynamical systems and difficulty of solving nonlinear problems.(2L) **Numerical programing:** Solving coupled ODE(s) using Euler, Heun, Runge-Kutta 4th order method in Fortran. Plotting and understanding vector field, bifurcation diagram					

	in XPPAUT/ MATLAB/ GEOGEBRA/ MATHEMATICA/ GNUPLOT etc. Solving PDE(s) using FTCS method in Fortran.(4L) **One Dimensional Flows:** fixed point and stability with example such as Logistic equation. Linear stability analysis, basics of existence and uniqueness criteria, impossibility of oscillations in 1D flow, concept of potential well; Bifurcation in 1D: Saddle Node, Transcritical, Pitchfork etc with concept of hysteresis, Imperfect bifurcations and Catastrophes with examples. Flows on the circle: Uniform and non-uniform oscillator. Ghosts and bottlenecks. Overdamped pendulum.(4L) **Two Dimensional Flows**: Linear systems with definition and example; Classification of linear systems, classification of fixed points: Saddle node, sink, source, spiral, centre, star, degenerate nodes, non-isolated fixed points etc and phase portrait; fixed point and linearization of nonlinear systems; Conservative systems, reversible systems; Limit Cycles: Van Der Pol oscillator, Lyapunov functions, Dulac's criterion, Poincare-Bendixson Theorem (quantitative description); Lienard systems, Relaxation Oscillators, weekly nonlinear oscillators: Duffing etc; Solution techniques: Regular perturbation theory and its failure; Multi-scale analysis, Method of Averaging, Renormalization of Group etc; Revisiting bifurcation in 2D flow: Saddle node, Transcritical, Pitchfork, Hopf, homoclinic and heteroclinic bifurcation. Bifurcation analysis using MATCONT/ XPPAUT softwares; oscillating chemical reactions. (14L) **Spatial Pattern forming systems:** Reaction-Diffusion systems, Dispersion relation, Turing Patterns.(2L) **Chaos:** Brief description of Chaos in 3D flow using Lorentz Oscillator, Lyapunov exponent etc. (2L) **Application:** Ecology: Romeo-Juliet love affairs/ Insect Outbreak dynamics/ flashing rhythm of fire-flies etc, Rabbit vs Sheep model/ Predator-Prey model, Grazing/ Harvesting model/ Lake-Eutrophication model etc, Critical/Tipping and Non-critical transitions and Early Warning Signals of Tipping. Chemistry: Turing pattern formation: Analysis and generation of spot, stipe, Labyrinth etc patterns using Gierrer Meinhardt/ Gray-Scott/ Belousov-Zhabotinski (BZ)/ Chlorine-dioxide-iodine-malonic acid (CDIMA) chemical reactions etc. Biology: Neuron system: Hodgkin-Huxley models/ FitzHugh-Nagumo model analysis, spike and pattern generation etc/ Circadian rhythm/ Glycolytic oscillator etc; Disease/Epidemics dynamics: Modelling infectious diseases: SIR, SIS model etc. (6L)
TextBooks,and/orreference material	1. Strogatz, S. Nonlinear Dynamics and Chaos. Reading, MA: Addison-Wesley, 2007. 2. Nonlinear Ordinary Differential Equations, D. W. Jordan, and P. Smith Oxford University Press 1999 3. Guckenheimer, J., and P. Holmes. Nonlinear Oscillations, Dynamical Systems and Bifurcations of Vector Fields. New York, NY: Springer-Verlag, 2002. 4. Introduction to Perturbation Techniques, Ali Hasan Nayfeh, WILEY-VCH Verlag GmbH & Co. KGaA, Weinheim, 2004. 5. Lakshmanan, M and R. Rajasekar, Nonlinear Dynamics: Integrability, Chaos and Patterns, Springer, 2003. 6. Clifford Henry Taubes. Modeling Differential Equations in Biology, Cambridge University Press, Second edition 2008.

CURRICULUM AND SYLLABUS FOR INTEGRATED MSC IN CHEMISTRY

Mapping of COs (Course Outcomes) and POs (Programme Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	3	3	2	1	3	3	2	1	1	1
CO2	3	2	3	3	3	1	3	3	3	3	1	2
CO3	3	2	3	3	3	3	3	3	2	3	1	2
CO4	3	2	3	3	3	3	3	3	3	3	3	3

Course Code	Titleof thecourse	ProgramCore (PCR)/Electives(PEL)	TotalNumberof contacthours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CYE913	**Advanced Spectroscopic Techniques and Applications of Group Theory**	PEL	3	0	0	3	3

Pre-requisites	Course Assessment methods [Continuous assessment (CA), mid-term (MT) and end termtest (ET)]
CYC701, CYC801	CA+MT+ET

CourseOutcomes	**CO1**:Fundamentalsoflaserandapplicationinscience andindustry **CO2**: Photoelectron spectroscopy, Mossbauer spectroscopy **CO3**: Modern techniques of fluorescence spectroscopy, **CO4**: Different aspects of fluorescence process **CO5**: GOT, SALC and Projection operator **CO6**: Different Applications of group theory in chemical bonding, IR and Raman spectroscopy, Electronic spectroscopy
TopicsCovered	1. Laser: Fundamentals, Characteristics, Q-switching, Mode-locking 2. Applications,Timeresolvedlaserspectroscopy(picosecond,femtosecondlaserspectroscopy)anditsapplication. (6 L) 3. Laser induced fluorescence spectroscopy and its application (3L) 4. Differentphotophysicalprocesses, photophysicalquenchingprocesses and its mechanism, Charge-transferprocesses (Marcustheory). Excited state life-time Fluorescencesensors and different mechanisms, Solvent effect on fluorescence, Lippert-mataga equation, Excited state dipole moment (8L) 5. X-ray photoelectron spectroscopy(4L**)** 6. Consequences of GOT and development of SALCs . 7. Applications of group theory in chemical bonding, IR and Raman spectroscopy,

	Electronic spectroscopy (14 L)
TextBooks,and/orreference material	1. Modern spectroscopybyJ.M.Hollas 2. Solidstatechemistryandits applicationbyWest 3. ChemicalKinetics byK.J.Laidler 4. OrganicandphysicalChemistryofPolymersbyYGnanouandM.Fontaanille,Wiley. 5. Atkin'sPhysicalChemistrybyP.AtkinsandJ. dePaula(7th ed.) 6. Fundamentalsof molecularspectroscopyByBanwelland McCash 7. FundamentalsofphotochemistryByRohatgi and Mukherjee. 8. Molecular symmetry and group theory by R. L. Carter

Mapping of COs (Course Outcomes) and POs (Programme Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	2	3	1	3	3	1	2	2
CO2	3	3	3	2	2	2	1	3	3	2	2	1
CO3	3	3	3	2	2	2	1	3	3	2	2	1
CO4	3	3	3	2	2	2	1	3	3	2	2	1
CO5	3	3	3	2	2	2	1	3	3	2	2	1
CO6	3	3	3	2	2	2	1	3	3	2	2	1

Course Code	Title of the course	Program Core (PCR)/Electives(PEL)	Total Number of contact hours				Credit
			Lecture(L)	Tutorial (T)	Practical (P)	Total Hours	
CYE914	**Surface Science, Electrode Kinetics and Corrosion Science**	PEL	3	0	0	3	3
Pre-requisites		Course Assessment methods [Continuous (CT), mid-term (MT) and end assessment (EA)]					
CYC505, CYC801		CT+MT+EA					
Course Outcomes	**CO1**:Process ofadsorptionandvariousadsorptionisothermsinvolvingdifferenttypes of adsorbate-adsorbent combination. Application of adsorption isothermto determinecatalyticefficiency. **CO2**: Basics of surfactants and micelles and their application in science andtechnology. **CO3**: Concept of electrical double layer, zeta potential and its role for colloidalstability. **CO4**: Kinetics of reaction at the electrode surface and its relevance towardsindustriallyimportant hydrogen evolutionfrom dissociation ofwater. **CO5**:Corrosionofvariousmetalsunderdifferentenvironmentalconditionsandmitigationmethods.						

Topics covered	**Adsorption on solid:** BET,Harkins-JuraandGibbsadsorptionisotherms,surfacetensionandsurfacepressure, contactangle:interfacialtension, temporary and permanent Hysteresis. (4 L) **Micellesandmicroemulsions:**Phasediagramofmicellarsystem. Hydroplilic-Lypophilic balance and application, Massactionmodelandpseudophasemodelfornon-ionicandionicmicelles.Relationshipbetweenthermodynamicpropertiesformicellization withCMC. Phase diagram of microemulsions. Packing factor and micellar stability. (2 L) **Nanoparticles**: Optical properties of nanoparticles. (2 L) **Electrical double layer and Electrokinetic effects:** Electrical double layer, Zeta potential, Stability of colloids, electroosmosis, electrophoresis, streaming potential etc. (3 L) **Electrode kinetics:** Derivation of Butler-volmer equation, Study of the kinetics of different electrode reactions (including elucidation of reaction mechanism). Polarizable and non-polarizable electrodes. Numerical problems. (4 L) **Corrosion science:** **Different forms of corrosion:** properties and remedial methods. (2 L) Tafel relation and mixed potential theory, Concept of exchange and limiting current density. (2 L) Potentiodynamicpolarizationandelectrochemicalimpedancespectroscopic methods to determine rate of corrosion. (3 L) **Corrosion control:** Cathodic (impressed sacrificial metal, current method and metallic coating) and anodic control methods. Numerical problems. (4 L) Application of corrosion inhibitors including green inhibitors. (2 L) High temperature corrosion: mechanism, kinetics and remedial measures. (2 L)
Text Books, and/or Reference material	1. ModernElectrochemistry2A-FundamentalsofElectrodicsbyBockrisandReddy 2. CorrosionEngineeringbyMG Fontana 3. CorrosionEngineeringbyBNPopov 4. SurfactantscienceandTechnology(3rded.) byD. Myers. 5. PrinciplesofcolloidandsurfacechemistryPCHiemenzandRRajgopalan

Mapping of COs (Course Outcomes) and POs (Programme Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	2	2	1	3	3	3	3	1
CO2	3	3	3	2	2	2	1	3	3	3	3	1
CO3	3	3	3	2	2	2	1	3	3	3	3	1
CO4	3	3	3	2	2	2	1	3	3	3	3	2
CO5	3	3	3	2	2	2	1	3	3	3	3	2

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CYE921	**Advanced Green Chemistry and Analytical Chemistry**	PEL	3	0	0	3	3
Pre-requisites		Course Assessment methods [Continuous (CT), mid-term (MT) and end assessment (EA)]					
NIL		CT+MT+EA					

Course Outcomes	**CO1**: Students will be given an introduction to green chemistry and learn about its basic concepts. **CO2**: Students will learn the application of green chemistry **CO3**: Demonstrate the design for safer, energy efficient technology and process optimization for cleaner industrial processes. **CO4**: Understand the fundamentals of pollution prevention technique with respect to health significance. **CO5**: Fundamental understanding of monitoring and analysis of air and water
Topics Covered	**Introduction to Green Chemistry**: 15 L Definition and strategic of green chemistry. Why Green Chemistry? Prevention, Atom Economy, Less Hazardous Chemical Syntheses, Designing Safer Chemicals, Safer Solvents and Auxiliaries, Design for Energy Efficiency, Use of Renewable, Feedstocks, Reduce Derivatives, Catalysis, Design for Degradation, Real-time analysis for Pollution Prevention, Inherently Safer Chemistry for Accident Prevention, Laboratory pollution prevention. **Application of Green Chemistry**: 10 L Applications and benefits of green chemistry: Production of new chemicals, materials, and products. Examples of successful green technologies; Alternative synthetic routes, new separation processes, new methods for delivery or product application (Alternative solvents, Energy vs. material activity). Importance of pollution and wastefulness in modern cultures by reflecting on the green chemistry. **Principle of Analysis for Air and Water samples**: 10 L Objectives of chemical analysis of air and water. Analysis of water: colour, turbidity, total solid, conductivity, acidity, alkalinity, hardness, chloride, sulfate, fluoride, phosphates, and different forms of nitrogen. Heavy metal analysis with respect to health significance. Measurement of DO, BOD and COD. Pesticides as water pollutants analysis. Monitoring and analysis of air: Monitoring technique through high volume sampler, SPM and RPM sampler. Measurement and analysis of SPM, RPM, SOX and NOX.
Text Books, and/or reference material	1. Green Chemistry, An Introductory Text By Mike Lancaster, RSC publications. 2. Handbook on Green Analytical Chemistry By Miguel de la Guardia, Salvador Garrigues, Wiley. 3. Innovations in Green Chemistry and Green Engineering By Paul T. Anastas, Julie Beth Zimmerman, Springer publications. 4. Alternative Solvents for Green Chemistry By Francesca M Kerton, Ray Marriott, RSC publications. 5. Environmental Chemistry with Green Chemistry By Asim Kumar Das, Books and Allied (P) Ltd.

Mapping of COs (Course Outcomes) and POs (Programme Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	2	1	3	3	3	2	3
CO2	3	2	3	2	3	2	1	3	3	3	3	3
CO3	3	2	2	2	3	2	1	3	3	3	2	3
CO4	3	3	3	2	2	3	1	3	3	3	3	3
CO5	3	3	3	2	2	3	1	3	3	3	3	3

Course Code	Title of the course	Program Core (PCR)/ Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CYE922	**Synthetic Methodology for Metal Complexes and Coordination Aggregates**	PEL	3	0	0	3	3
Pre-requisites		Course Assessment methods [Continuous assessment (CA), mid-term (MT) and end term (ET)]					
CYC602 & CYC702		CA+MT+ET					
Course Outcomes	**CO1**: Understand the importance of transition metal complexes **CO2**: Basic knowledge of different types of ligands and their applications **CO3**: Primary Concept of designing and synthesis of a ligand **CO4**: Learn about the different aspects of supramolecular chemistry **CO5**: Clear idea about the synthesis of diversified macrocycles **CO6**: Fundamentals of thermodynamic effects upon changing the cavity size of a macrocycle						
Topics covered	Introduction, Importance of ligand design and their applications in metal-complex formation. (6 L) Nitrogen Based Ligand: N_2 as Ligand, Reactivity of Bound N_2, Macrocyclic Amines, Polyimines, Porphyrin, Polypyrazolylborate Ligand, Hydroxylamido Ligand, Schiff Base Ligand, Azide and Other Anionic Ligand. (5 L) Phosphorus Based Ligands: Phosphine as Ligand, Monophosphines, Diphosphines, PolydentatePhosphines, Phosphate Ligands, Heterocyclic Phosphorus Ligands, Dialkyl- and Diarylphosphido Ligands. (4 L) Oxygen Based Ligand: Dioxygen, Sueroxo and Peroxo Ligand, Alkoxides and Aryloxides, Ketone and Ester, Crown Ethers, β-Ketoenolato and Related Ligands, Carbamates, Oxo Anions as Ligands. (5 L) Sulphur Based Ligand: Thiolates, Disulphides, Thioethers, Sulphur Oxide, Dithiocarbamates, 1,2-Dithiolenes. (3 L) Metal-Organic Frameworks (MOF) (2 L)						

Topics Covered	Supramolecular Chemistry: Introduction, Host-Guest Chemistry, SelfAssembly, Supramolecular Building Blocks and Spacer, Driving Forces for the Formation of Supramolecular Structure. (2 L) Spatial Relationships between Host and Guest, Classification of Host-Guest Compounds, General Introduction to Podand, Coronand, Spherand, Coronand-Podand Hybrid, Cryptands. (2 L) The Chelate and Macrocyclic Effect on Host-Guest Binding, Synthesis of Crown Ethers, The Template Effect, Synthesis of Cryptands, Recent Developments in the Synthesis of Cryptands, Synthesis of Aza Crown Ethers and Related Compounds. (3 L) Chiral Crown Ethers, Proton Ionisable Crown Ethers, Diester Crown Ethers, Synthesis of Lariat Ethers. (2 L) Synthesis of Calix[n] Arenes, Chiral Calix[n] Arenes, Introduction of Functional Groups in Calix[n] Arenes, Reactions at Upper Rim of Calixarene. (3 L) Selectivity of Cation Complexation, Cation Binding by Crown Ethers, Cation Binding by Lariat Ethers, Cation Binding by Cryptands, Thermodynamic Effect of Binding. (4 L)
Text Books, and/or reference material	1. An Introduction to Supramolecular Chemistry by Asim K Das and Mahua Das. 2. Analytical Chemistry of Macrocyclic and Supramolecular Compounds by S. M. Khopkar. 3. Advanced Inorganic Chemistry by F. A. Cotton, G. Wilkinson, C. A. Murillo and M. Bochmann. 4. Synergy in Supramolecular Chemistry edited by Tatsuya Nabeshima. 5. Concepts and Models of inorganic chemistry by B. E. Douglas, D. H. McDaniel and J. J. Alexander.

Mapping of COs (Course Outcomes) and POs (Programme Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	2	1	--	3	3	2	--	1
CO2	3	3	3	3	1	--	1	3	3	1	1	1
CO3	3	3	3	3	2	2	--	3	3	2	--	1
CO4	3	--	3	2	2	2	1	3	1	1	1	1
CO5	3	3	3	3	2	2	1	3	3	2	1	1
CO6	3	--	3	2	2	1	1	3	2	1	--	1

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CYE923	**Small Molecule Activation, Nuclear Chemistry and Related Spectroscopy**	PEL	3	0	0	3	3
Pre-requisites		CourseAssessmentmethods[Continuousassessment(CA),mid-term(MT)andendterm (ET)]					
CYC702		CA+MT+ET					
Course	**CO1**: Diversified biological roles of Nitric Oxide (NO) and the NO donor drugs, Enemark-Feltham $\{MNO\}^n$ notation of metal nitrosyls and their spectroscopic and						

Outcomes	structural properties to elucidate structure-function relationship, electrophilic and nucleophilic reactivity of metal coordinated NO. **CO2**: Active site structure and role of denitrifying bacteria responsible for nitrite (NO_2^-), nitric oxide (NO) and nitrous oxide (N_2O) reduction to N_2 sustaining global N_2 cycle, structure function of Metalloenzymes responsible for N_2 fixation. **CO3**: Basics of nuclear chemistry, the nuclear spin (I), quadrupole moment (Q) and ellipticity of the nuclides and numerical problems, Binding energy and related numerical problems; Nuclear spin, quadrupole moment and Ellipticity of the nucleus and numerical problems. **CO4**: The concepts and working principle of three spectroscopy such as Nuclear Magnetic Resonance (NMR), Electron Paramagnetic Resonance (EPR) and Mössbauer spectroscopy. **CO5**: EPR spectroscopy, Interaction of electron spin and nuclear spin with magnetic field, interaction of nuclear spin with electron spin (hyperfine, superhyperfine coupling), importance of g values and its determination, Zero field splitting, Kramer's degeneracy and applications of EPR measurements to elucidate the chemical bonding properties. **CO6**: Mössbauer Spectroscopy, Frequency broadening and Doppler Effect, Decay schemes of Mössbauer nuclides, applications of Mössbauer Spectroscopy to elucidate the oxidation states, spin states, site symmetry and bonding properties of Mössbauer nuclides (importance of Quadrupole splitting and Isomer shift values).
Topics Covered	**Small Molecule Activation:** Importance of NO as ligand and its diverse roles in biology, NO Synthase enzyme and NO donors including metal nitrosyls, MO diagram of NO and its various binding modes, Enemark-Feltham $\{MNO\}^n$ notation, Spectroscopic and structural properties of various $\{MNO\}^n$ species (M = Fe and Cu), NO detection methods, Electrophilic and nucleophilic reactivity on metal activated NO moiety. (7L) Naturally occurring activation of small molecules like nitrate (NO_3^-), nitrite (NO_2^-), nitric oxide (NO), nitrous oxide (N_2O) and nitrogen (N_2) related to the Denitrification and N_2 Fixation pathways of Nitrogen Cycle. Enzymes involved for such activation of small molecules and their active site structures, catalytic activity and impact on Atmospheric Nitrogen Cycle. Organic nitrile (RCN) activation by Nitrile Hydratse enzyme. (9L) **Nuclear Chemistry:** Concept of Quarks; Size, shape, stability and classification of nuclides, Nuclear potential diagram, Packing fraction, Mass defect, Binding energy and related numerical problems, Quantum numbers of nucleons and magnetic properties, Nordheim rules, Nuclear magnetic resonance and its application to medical diagnosis such as MRI, Electric quadrupole moment of the nuclides and concept of electric multipoles; Nuclear spin (I), quadrupole moment (Q) and Ellipticity of the nucleus and numerical problems. Nuclear shell model, magic number and periodicity of nuclear properties. (8L) **Spectroscopy related to nuclear spin:** (1) **Electron Paramagnetic/Spin Resonance (EPR/ESR) Spectroscopy:** Interaction between nuclear/electron spin with magnetic field, techniques of EPR spectroscopy, Relaxation time and line width in EPR transition, EPR relaxation and chemical bonding, Interaction of nuclear spin with electron spin (hyperfine, superhyperfine coupling), g values and factors affecting it, determination of g values, Zero field splitting, Kramer's degeneracy and applications of EPR measurements. (5 L) **(2) Nuclear resonance or recoilless absorption and Mössbauer Spectroscopy:** Recoiling Frequency shift, Frequency broadening and Doppler

	effect, Characteristics of Mössbauer nuclides and related Decay schemes, Quadrupole splitting, Isomer shift and its application to assign the oxidation state, spin state, site symmetry and bonding properties of Mossbauer nuclides. (5L)
Text Books, and/or reference material	1. Nitric Oxide Research (Eds. M. Feelish, J.S. Stamler) Wiley, Chichester, 1996. 2. Activation of Small Molecules, William B. Tolman, Wiley. 3. Bioinorganic Chemistry: Inorganic Elements in the Chemistry of Life, Wolfgang Kaim and Brigitte Schwederski, Wiley 4. Essentials of Nuclear Chemistry, H. J. Arnikar, New Age International Publishers, 2009 5. Nuclear Physics, Irving Kaplan, Narosa Publishing House, 2002 6. Modern Nuclear Chemistry, W. D. Loveland, D. J. Morrisey, Glenn T. Seaborg, Wiley. 7. Elements of Magnetochemistry, R. L. Dutta & A. Syamal, East-West Press Pvt Ltd., New Delhi, India.

Mapping of COs (Course Outcomes) and POs (Programme Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	2	3	3	3	3	2	1	1
CO2	3	2	3	2	2	2	3	3	3	2	1	1
CO3	3	2	3	2	2	2	1	3	2	2	1	1
CO4	3	3	3	2	2	3	1	3	2	3	1	1
CO5	3	3	3	2	2	3	1	3	2	3	1	1
CO6	3	3	3	3	2	3	1	3	2	2	1	1

Course code	Title of the course	Program Core (PCR)/Electives (PEL)	Total number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total hours	
CYE924	**Application of Group Theory and Applied Electrochemistry**	PEL	3	0	0	3	3
Pre-requisites		CourseAssessmentmethods[Continuousassessment(CA),mid-term(MT) andend term (ET)]					
CYC501 and CYC601		CA+MT+ET					
Course outcomes	**CO1**: To know group, examples, vector space, matrix and matrix operator. **CO2**: To know point group and its representations, reducible and irreducible representation. **CO3**: To know the significance of character tables of point group and its application in chemical problems. **CO4**: To get knowledge of thermodynamics and kinetics of electrochemical processes. **CO5**: To get foundation in different electrochemical methods like cyclic voltammetry coulommetry and its applications in inorganic fields.						
Topics covered	Group theory: vector space and matrix , representation of groups, techniques and relationships for chemical applications, symmetry and chemical bonding, equation of wave functions, vibrational spectroscopy, transition metal complexes. (24 L)						

	Electrochemistry: fundamental of electrode reaction, basic equipment for electrochemical measurements,voltametric techniques, electrochemical behaviour of transition metal complexes, metal complexes containing redox active ligands. (12 L)
Text Books, and/or reference materials	1. Chemical applications of Group theory, F.A.Cotton John Wiley &sons Inc 2. Group Theory and Chemistry, David M Bishop, Dober Publication Inc 3. Molecular Symmetry and group theory, R.L. Carter, John Wiley &sons Inc 4. Inorganic Electrochemistry, Theory practice and application, P. Zanello,R.Sc.

Mapping of COs (Course Outcomes) and POs (Programme Outcomes)

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	3	3	3	2	2	1	3	3	3	1	1
CO2	2	2	3	3	2	1	1	3	3	3	1	1
CO3	1	3	3	3	2	2	1	3	3	3	1	1
CO4	3	3	3	3	2	2	1	3	3	3	1	1
CO5	3	2	3	3	2	3	1	3	3	3	1	1

CourseCode	Titleofthecourse	Program Core(PCR)/ Electives(PEL)	TotalNumberofcontacthours				Credit
			Lecture (L)	Tutorial(T)	Practical (P)	TotalHours	
CYE931	**AdvancedOrganic Synthesis**	PEL	3	0	0	0	3

Pre-requisites	CourseAssessmentmethods:[Continuousassessment(CA),mid-term(MT) andend term (ET)]
None	CA+MT+ET

CourseOutcomes	**CO1**:Understandingofmechanismoforganic specificreactions,theirapplication in differentfieldofsyntheticorganicchemistry. **CO2**: Uses of strategy and control of Hydroboration and Wittig reaction for carbon-carbon and other special types ofbondformation. **CO3**: Birchreduction,how the better yieldof product could beobtained, theirtactics,strategy andcontrolhas beenhighlighted. **CO4**: Role of specific reagents with related mechanism in their transformationandtheirmechanismfromsubstratetoproductsisincludedfortheirstepbystepsynthesis. **CO5**: Research oriented study with innovative idea.

TopicsCovered	1. Hydroborationreactionofalkenes,mechanismandhydrolysisprocess,Regioselectivity,stereoselectivityandEnantioselectivehydroborationreaction, Uses of 9-BBN (in Suzuki Cross coupling reaction and others) andMonoisocamphenylborane(IpcBH2),isomerisationofalkenesviahydroboration reactions, Carbon-Nitrogen, Carbon-halogen bond formation,synthesisofcyclopropyl,cyclobutylderivativesandbicyclocompounds. (10L) 2. BirchReduction:Mechanism,dependentfactors,Applicationofbirchreductionin aminolysis, hydrogenolysis, Wilds& Nelsen modificationforpure products in Birch reduction, Regio-selectivity of Birch reduction. Hinepostulates; Reduction of substitute benzenoid systems with EWG and EDG;biphenyl systems, regio-selective reduction of naphthalene and substitutednaphthalene; Stereo selective of Birch reduction in naphthalene. Reductionof Anthracene and Phenanthrene systems; single electron transfer system(SET),applicationinnaturalproductsynthesiswithspecialemphasison. (10L) 3. Wittig reactions or chemistry of Ylide: synthesis of phosphoylide; Stereo-chemical outcome of wittig reactions and their dependent factors. Stereo-selectivityincaseofstabilisedandnonstabilized ylides.Scholarmodifications. Effect of ligands in phosphorous ylide. Advantages of Wittig-Horner reaction over Wittig reaction; Difference in reactivity of phosphorousandsulphurylide;Regioselectiveandstereo-selectivereactionwithstabilizedandnon-stabalizessulfurylides. (10L)
Text Books,and/orreferencematerial	1. F.A.Carey&R.J.Sundberg,AdvancedOrganicChemistry,Springer,2007 2. K.C.Nicolaou&E.J.Sorensen,ClassicsinTotalSynthesis:Targets,strategiesandMethods,Wiley, 1996. 3. W.Carruthers,ModernMethodsinOrganicSynthesis,CambridgeUniversityPress,2004. 4. PrinciplesofOrganicSynthesis,R.O.C.Norman&J.M.Coxon,NelsonThrones,1993,CRCPress. 5. OrganicsynthesisbyM.Smith,Elevier,4thEdition,2016. 6. Recent published papers in reputed journals on Hydroboration reaction, Wittigreaction and Birch reduction have to follow as advance study for this electivepaper.

Mapping of COs (Course Outcomes) and POs (Programme Outcomes)

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	3	3	3	2	3	3	3	1	3	1
CO2	3	3	2	3	2	2	3	2	3	3	1	2
CO3	3	2	3	2	1	3	2	2	2	2	2	1
CO4	1	2	1	3	2	2	3	2	1	2	1	2
CO5	3	2	2	1	3	2	2	3	2	1	1	3

Course Code	Title of the course	Program Core (PCR)/ Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CYE932	**Drug Design and Biophysical Chemistry**	PEL	3	0	0	3	3
Pre-requisites		CourseAssessmentmethods:[Continuousassessment(CA),mid-term(MT) andend term (ET)]					
CYC401		CA+MT+ET					

Course Outcomes	**CO1**: Introduction to Medicinal Chemistry and Drug Discovery **CO2**: Concept generation on drug mechanism, classification, pharmacokinetics/pharmacodynamics **CO3**: Overview of conventional and advanced methods in rational drug design. **CO4**: Introduction to different biophysical processes inside important biomolecules **CO5**: Learning of techniques used for macromolecular separations. **CO6**: Develop knowledge on various instrumental techniques used in Biophysical Chemistry
Topics Covered	**Drug Design:** Introduction: Definition of drugs, difference between drugs and toxins, molecular targets of drugs, different Intermolecular binding interactions between drug and targets. (3 L) Enzyme inhibitor drugs: Real examples of known drugs (anti-bacterial, anti-cholesterol, anti-obesity, anti-biotic, anti-viral, anti-hypertension) with their mechanism of action. (3 L) Pharmacokinetics and pharmacodynamics in drug action: Median lethal dose LD50, Half maximal effective concentration EC50, Therapeutic index TI, Lipinski's Rule, ADMET, Bioavailability and Gastrointestinal (GI) absorption of a drug, volume of distribution Vd, Phase-I/Phase-II metabolism of drugs and example of toxicity, Role of CYP enzymes, Drug's half-life and steady-state concentration. (3 L) Rational design of drugs: Mechanism based drug design, lead compound, purpose of drug design (improvement of selectivity, improvement of ADMET profiles) with examples of real drugs, Molecular modification (Molecular association and dissociation) in drug design, High-throughput screening (HTS) method. (3 L) Computer-aided drug design: Role of computer in drug design, Basic modeling strategy, Virtual screening, homology modeling, Structure-based drug design, Molecular docking, Ligand-based drug design, 3D-QSAR, 3D-pharmacophore, Database screening, De novo drug design. (3 L) **Biophysical Chemistry:** Enzyme kinetics and Enzyme inhibition: Introduction of Enzyme, Enzyme-substrate Kinetics, Enzyme inhibition, Reversible inhibition, Irreversible inhibition, Competitive Inhibitor, Allosteric Inhibitor, Non-Competitive Inhibitor, Biophysical and kinetics studies of enzyme-inhibitor complex. (3 L) Molecular Forces in Biological Structures: Electrostatic interactions, hydrophobic and hydrophilic forces, hydrogen bonding interactions, ionic interactions, stabilizing forces in proteins and nucleic acids, steric interactions. (3 L) Techniques for macromolecular separation: Ion exchange, Salting-in and salting-out, dialysis, sedimentation, electrophoresis and isoelectric focusing, gel filtration and ion-exchange chromatography, HPLC. (3 L) Concept generation and applications of biophysical instruments to study the Structure-Function Inter-relationships of biomolecules: Application of spectroscopy instruments (UV-VIS, NMR, CD, Mass) in characterization of biomolecules, Application of protein crystallography and XRD in understanding the structure of proteins, Application of Isothermal Titration Calorimetry (ITC) in analysing protein-ligand binding, Application of different gel-based assays (SDS-PAGE, Native PAGE, denaturing PAGE, Agarose), Application of multimode plate reader. (8 L)

Text Books, and/or reference material	1. An Introduction to Medicinal Chemistry by G L Patrick (Oxford) 2. Bioinformatics and Computational Biology in Drug Discovery and Development by William T. Loging (Cambridge) 3. The organic chemistry of drug design and drug action by Richard Bruce Silverman 4. Principles of Physical biochemistry by Holde, Johnson and Ho 5. Experimental biophysical Chemistry By Copeland, R. A.

Mapping of COs (Course Outcomes) and POs (Programme Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	1	1	2	1	2	3	3	3	1
CO2	3	3	3	1	1	2	1	3	2	2	2	2
CO3	3	2	3	1	1	3	3	3	3	3	3	1
CO4	3	1	3	1	1	2	1	2	2	3	1	1
CO5	3	3	3	3	3	3	1	3	3	1	3	2
CO6	3	3	3	3	3	3	1	3	3	1	3	1

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total hours	
CYE933	**Bioorganic Chemistry & Natural Products**	PEL	3	0	0	3	3
Pre-requisites		CourseAssessmentmethods:[Continuousassessment(CA),mid-term(MT) andend term (ET)]					
CYC401, CYC503		CA+MT+ET					
Course Outcomes	**CO1**: To generate concept on the interdisciplinary interface lies within Chemistry and Biology **CO2**: To develop knowledge on the enzyme chemistry **CO3**: To understand the enzyme inhibitors and inhibition kinetics **CO4**: To learn the structures, synthesis and uses of different terpenes **CO5**: To know the chemistry of alkaloids **CO6**: To know the chemistry of Steroids in hormones						
Topics Covered	**Bioorganic Chemistry:** **18 L** Enzymes: Chemical and biological catalysts. Nomenclature and classification, concept and identification of active sites by use of inhibitors, catalytic power, specificity and regulation. Different types of enzyme catalyzed reactions, Co-enzyme chemistry. Enzyme kinetics: Michaelis-Menten and Lineweaver-Burk plots, reversible and irreversible inhibition. Mechanism of enzyme action. Enzyme models: Host-guest chemistry, chiral recognition, molecular asymmetry and prochirality, biomimetic chemistry, crown ether, cryptates, cyclodextrins, calixarin. (8 L) Examples of some typical enzyme mechanisms: chymotrypsin, carboxypeptidase-A, Lysozyme. (3 L) Chemical models and mimics for enzymes, receptors, peptides, carbohydrates and other bioactive molecules, catalytic antibodies- Design, synthesis and evaluation of enzyme inhibitors. (4 L) Enzyme catalyzed reactions: Carboxylation and decarboxylation. Isomerization and rearrangement. (3 L)						

	Natural Products **18 L** **Terpenoids:** Classification, isoprene rule, general methods of isolation and structure determination. Biogenetic pathway of mono and sesquiterpenes. Synthesis of α-santonin, abietic acid, gibberellic acid, menthol, caryophyllene and longifolene. (6 L) **Alkaloids:** Extraction, structure determination and chemistry of alkaloids special reference to nicotine, piperine, papaverine, atropine and morphine. (6 L) **Steroids:** Synthesis, stereochemistry and reactions of steroids. Cholesterol, and its biosynthesis, Sex hormones: Estrogens, androgens and progestin, D-Vitamins and reactions of steroid. (6 L)
Text Books, and/or reference materials	Suggested Text Books: 1. Principles of Biochemistry by Lehninger 2. Biochemistry by Voet & Voet 3. Asymmetric Synthesis of Natural products By Ari M P Koskinen (Wiley) Suggested Reference Books: 4. Chemistry of Natural Products By S B Bhat, B. A. Nagasampagi, M. Sivakumar (Narosa). 5. Chemistry of Plant Natural Products by S. K. Talapatra & B. Talapatra (Springer)

Mapping of COs (Course Outcomes) and POs (Programme Outcomes)

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	2	2	1	3	3	1	1	2
CO2	3	3	3	3	2	2	1	3	3	1	1	2
CO3	3	3	3	3	2	2	1	3	3	1	1	2
CO4	3	3	3	2	2	2	1	3	3	2	1	2
CO5	3	3	3	2	2	2	1	3	3	2	1	2
CO6	3	3	3	2	2	2	1	3	3	2	1	2

Course Code	Title of the course	Program Core (PCR) /Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CYE934	**Advanced Stereochemistry and Structure Activity Correlation**	PEL	3	0	0	3	3
Pre-requisites		CourseAssessmentmethods:[Continuousassessment(CA),mid-term(MT) andend term (ET)]					
CYC303		CA+MT+ET					

Course Outcomes	**CO1**: Learn about the three-dimensional structure of organic molecules, which govern their reactivity in different reactions. **CO2**: Advance stereochemistry helps to synthesize biological active compounds with better yield and minimum by-products. **CO3**: In the field of drug design & drug delivery, insecticides and pesticides, new bio-active molecules could be synthesized for better utility in field of pharmaceutical science, agriculture and material science. **CO4**: It helps to understand the basic knowledge in synthesis of organic molecules and to obey the guidelines of green chemistry principle. **CO5**: With help of knowledge in stereochemistry and structural correlation, the hurdle in stereochemical problem in industries in large scale production of polymer, drug etc. could be solved.
Topics Covered	1. Advanced stereochemistry: Configarational analysis: Relative and absolute configuration. (2 L) 2. Determination of relative configuration: (i) Chemical correlation not affecting the chiral atom, (ii) Chemical correlation affecting bonds to the chiral atom in a 'known way' (iii) Correlation by asymmetric synthesis: Horeaus rule, Prelog's rule, Cram's rule (Felkin modification), and Sharpless rule (iv) Physical methods: NMR, MS, IR, dipole moment, ORD, CD. (8L) 3. Optical rotation and optical rotatory dispersion: Preliminary concept about linearly polarised light (LP), RCP and LCP; circular birefringence; and circular dichroism and optical rotatory dispersion; Cotton effect; ORD of ketones and Octant rule. (8 L) 4. Conformation of acyclic and cyclic system (3-8 membered rings), decalin, octalene, and bridged bicyclo systems; stability, reactivity and mechanism, Cortin Hammett principle and Winstein-Eliel equation (special emphasis on 5 and 6 membered rings with and without heteroatoms like O, S and N). (8L) 5. Quantitative relationship between structure and reactivity: (i) Liner free energy relation: Hammett equation; Equilibrium and rate in organic reactions; (ii) Separation of polar, steric and resonance: (iii) Taft equation; (iv) Grunwald-Winstein equation. (iv) Some application of structure-reactivity correlation study. (8 L)
Text Books, and/or reference material	1. Stereochemistry of Carbon Compounds. Ernest L. Eliel. McGraw-Hill 2. Basic Stereochemistry of Organic Molecules, Oxford University Press: Subrata Sen Gupta 3. Stereochemistry Of Organic Compound; Principle and Applications by D. Nasipuri 4. Stereochemistry. Conformation and Mechanism. P. S. Kalsi

Mapping of COs (Course Outcomes) and POs (Programme Outcomes)

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	3	2	2	2	1	3	2	2	1	2
CO2	3	2	3	2	2	2	2	3	2	2	1	2
CO3	3	2	3	2	2	2	2	3	2	2	1	2
CO4	3	3	3	2	2	3	1	3	2	3	1	2
CO5	3	3	3	2	2	3	2	3	2	3	1	2