CURRICULUM AND SYLLABUS FOR INTEGRATED MSC IN CHEMISTRY

NATIONAL INSTITUTE OF TECHNOLOGY DURGAPUR

CURRICULUM

OF

INTEGRATED MSC IN CHEMISTRY

2017 ONWARD UNDERGRADUATE ADMISSION BATCH

V0:

Resolution of 50th Senate	18-05-2018	Item no: 50.7
Resolution of 51st Senate	04-10-2018	Item no: 51.2
Resolution of UGAC meeting	10-05-2019	
Final approval in 53rd Senate	13-05-2019	Item no: 52.3
Publication date	30-05-2019	

V1:

Incorporation of new elective subjects	27-06-2019

V2:

Rectification of minor errors	UGAC 31-08-2022

Final Approval in 67th Senate dated 20/09/2022 vide Item no: # 67.3

CURRICULUM AND SYLLABUS FOR INTEGRATED MSC IN CHEMISTRY

DEPARTMENT OF CHEMISTRY

Program Name: Int. M. Sc. in CHEMISTRY

DETAILED CURRICULUM

CURRICULUM OF 2021 ONWARD UNDERGRADUATE ADMISSION BATCH FOR Int. 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.

Semester - I							
Sl. No	**Code**	**Subject**	**L**	**T**	**S**	**C**	**H**
1	MAC01	Mathematics - I	3	1	0	4.0	4
2	PHC01	Engineering Physics	2	1	0	3.0	3
3	CYC01	Engineering Chemistry	2	1	0	3.0	3
4	XEC01	Engineering Mechanics	2	1	0	3.0	3
5	ESC01	Environmental Science	2	0	0	2.0	2
6	XES51	Engineering Graphics	1	0	3	2.5	4
7	HSS51	Professional Communication Laboratory	1	0	2	2.0	3
8	PHS51	Physics Laboratory	0	0	2	1.0	2
9	CYS51	Chemistry Laboratory	0	0	2	1.0	2
10	WSS51	Workshop Practice	0	0	3	1.5	3
11	XXS51	Co-curricular Activities - I	0	0	2	1.0	2
		TOTAL	13	4	14	24.0	31
Semester - II							
Sl. No	**Code**	**Subject**	**L**	**T**	**S**	**C**	**H**
1	MAC02	Mathematics - II	3	1	0	4.0	4
2	CSC01	Introduction to Computing	2	1	0	3.0	3
3	ECC01	Basic Electronics	2	1	0	3.0	3
4	EEC01	Electrical Technology	2	1	0	3.0	3
5	BTC01	Life Science	2	0	0	2.0	2
6	XXC01	Constitution of India and Civic Norms	1	0	0	1.0	1
7	XES52	Graphical Analysis using CAD	0	0	2	1.0	2
8	CSS51	Computing Laboratory	0	0	2	1.0	2
9	ECS51	Basic Electronics Laboratory	0	0	2	1.0	2
10	EES51	Electrical Technology Laboratory	0	0	2	1.0	2
11	XXS52	Co-curricular Activities - II	0	0	2	1.0	2
		TOTAL	12	4	10	21.0	26
Semester - III							
Sl.	**Code**	**Subject**	**L**	**T**	**S**	**C**	**H**
1	MAC331	Mathematics - III	3	1	0	4.0	4
2	CYC301	State of Matter and Chemical Thermodynamics	3	1	0	4.0	4
3	CYC302	Atomic Structure and Chemical Bonding	3	1	0	4.0	4
4	CYC303	Stereochemistry and Basic Principle of Organic Chemistry	3	1	0	4.0	4
5	PHC334	Physics - II	3	0	0	3.0	3
6	PHS384	Physics- II Laboratory	0	0	3	1.5	3
7	CYS351	Qualitative Analysis of Organic Samples Laboratory	0	0	3	1.5	3
8	XXS381	Co-curricular Activities - III (optional)	0	0	0	0.0	0
		TOTAL	15	4	6	22.0	25

CURRICULUM AND SYLLABUS FOR INTEGRATED MSC IN CHEMISTRY

Semester - IV							
Sl.	**Code**	**Subject**	**L**	**T**	**S**	**C**	**H**
1	CYC401	Biochemistry: Structure and Function	3	0	0	3.0	3
2	CYC402	Phase-Equilibrium, Chemical Kinetics and Catalysis	3	1	0	4.0	4
3	CYC403	Chemistry of Elements and Radioactivity	3	1	0	4.0	4
4	CYC404	Organic Reaction Mechanism and Reactive Intermediates	3	1	0	4.0	4
5	YYO44*	Open Elective - 1	3	0	0	3.0	3
6	CYS451	Thermodynamic Properties of Solution and Mixture Laboratory	0	0	4	2.0	4
7	CYS452	Identification of Acidic and Basic Radicals Laboratory	0	0	4	2.0	4
8	CYS453	Biochemistry Laboratory	0	0	3	1.5	3
9	XXS481	Co-curricular Activities - IV (optional)	0	0	0	0.0	0
		TOTAL	15	3	11	23.5	29
Semester - V							
Sl.	**Code**	**Subject**	**L**	**T**	**S**	**C**	**H**
1	CYC501	Fundamentals of Electrochemistry and Surface Chemistry	3	1	0	4.0	4
2	CYC502	Chemistry in Solution and Solid State Chemistry	3	1	0	4.0	4
3	CYC503	Chemistry of Heterocyclic Compounds and Natural Products	3	1	0	4.0	4
4	CYC504	Industrial Chemistry	3	0	0	3.0	3
5	YYO54*	Open Elective - 2	3	0	0	3.0	3
6	CYS551	Chemical Kinetics, Surface Chemistry and Conductometry	0	0	3	1.5	3
7	CYS552	Quantitative estimation of metal ions in mixture	0	0	4	2.0	4
8	CYS553	Quantitative Analysis of Organic Samples	0	0	3	1.5	3
9	XXS581	Co-curricular Activities- V (optional)	0	0	0	0.0	0
		TOTAL	15	3	10	23.0	28
Semester - VI							
Sl.	**Code**	**Subject**	**L**	**T**	**S**	**C**	**H**
1	CYC601	Basics of Photochemistry, Spectroscopy, Group Theory and Data Analysis	3	1	0	4.0	4
2	CYC602	Coordination Chemistry	3	1	0	4.0	4
3	CYC603	Reagents in Organic Synthesis	3	1	0	4.0	4
4	CYE611/2	Departmental Elective-1	3	0	0	3.0	3
5	XEC631	Economics and Management Accountancy	3	0	0	3.0	3
6	CYS651	Potentiometric and Colorimetric Analysis	0	0	3	1.5	3
7	CYS652	Analysis of Ores and Alloys	0	0	4	2.0	4
8	CYS653	Single Step Synthesis of Organic Compounds	0	0	4	2.0	4
9	CYS654	Comprehensive Viva Voce - I	0	0	0	1.0	0
10	XXS681	Co-curricular Activities - VI (Optional)	0	0	0	0.0	0
		TOTAL	15	3	10	24.5	28

CURRICULUM AND SYLLABUS FOR INTEGRATED MSC IN CHEMISTRY

Semester - VII							
Sl. No	**Code**	**Subject**	**L**	**T**	**S**	**C**	**H**
1	MSC731	Principles of Management	3	0	0	3.0	3
2	CYC701	Quantum Chemistry and Spectroscopy	3	1	0	4.0	4
3	CYC702	Inorganic Reaction Mechanisms and Magnetochemistry	3	1	0	4.0	4
4	CYC703	Concept of Organic Synthesis and Asymmetric Synthesis	3	1	0	4.0	4
5	CYC704	Mathematical and Computational Chemistry	3	0	0	3.0	3
6	CYS751	Spectrophotochemical Analysis	0	0	3	1.5	3
7	CYS752	Spectrophotometric Estimation of Cations and Anions	0	0	3	1.5	3
8	CYS753	Separation and Identification of Organic Compounds from Binary Mixture	0	0	4	2.0	4
		TOTAL	15	3	10	23.0	28
Semester - VIII							
Sl. No	**Code**	**Subject**	**L**	**T**	**S**	**C**	**H**
1	CYC801	Chemical, Statistical Thermodynamics and Electrochemistry	3	1	0	4.0	4
2	CYC802	Organometallic Compounds and Bioinorganic Chemistry	3	1	0	4.0	4
3	CYC803	Pericyclic Reactions and Organic Photochemistry	3	1	0	4.0	4
4	CYE811/2	Departmental Elective- 2	3	0	0	3.0	3
5	CYS851	Advanced Practical Physical Chemistry	0	0	4	2.0	4
6	CYS852	Synthesis and Characterisation of Complex Compounds	0	0	3	1.5	3
7	CYS853	Chromatographic Separation of Organic Compounds	0	0	3	1.5	3
		TOTAL	12	3	10	20.0	25

Semester - IX							
Sl. No	**Code**	**Subject**	**L**	**T**	**S**	**C**	**H**
1	CYE9 --	Special subject -1	3	1	0	4.0	4
2	CYE9 --	Special subject -2	3	1	0	4.0	4
3	CYE9 --	Special subject -3	3	1	0	4.0	4
4	CYE9 --	Special subject -4	3	1	0	4.0	4
5	CYS9 --	Special subject Sessional	0	0	3	1.5	3
6	CYS954	Project- I	0	0	3	1.0	4
7	CYS955	Vocational training/ Summer internship/ Term Paper	0	0	0	1.0	0
8	CYS956	Comprehensive Viva Voce - II	0	0	0	1.5	0
		TOTAL	12	4	07	21.0	23
Semester - X							
Sl. No	**Code**	**Subject**	**L**	**T**	**S**	**C**	**H**
1	CYS1051	Project – II/ Internship	0	0	30	10.0	30
2	CYS1052	Seminar & Viva voce	0	0	0	2.0	0
		TOTAL	0	0	30	12.0	30

CURRICULUM AND SYLLABUS FOR INTEGRATED MSC IN CHEMISTRY

CREDIT UNIT OF THE PROGRAM:

Semester	I+II	III	IV	V	VI	VII	VIII	IX	X	Total
Credit units	44.0	22.0	23.5	23.0	24.5	23.0	20.0	21.0	12.0	213.0

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.

SIXTH SEMESTER	
CYE611	Analytical and Environmental Chemistry
CYE612	Chromatographic Separation and Instrumental Methods of Analysis

EIGHT SEMESTER	
CYE811	Advanced Natural Products and Medicinal Chemistry
CYE812	Spectroscopic Methods of Chemical Analysis

NINTH SEMESTER	
CYE911	Advanced Quantum Chemistry and Application of Group Theory
CYE912	Non-Equilibrium Thermodynamics and Biophysical Chemistry
CYE913	Material chemistry and advanced spectroscopy
CYE914	Electrode kinetics and corrosion science
CYS951	Advanced Physical Chemistry-II Laboratory
CYE921	Advanced Green Chemistry and Analytical Chemistry
CYE922	Synthetic Methodology for Metal Complexes and Coordination Aggregates
CYE923	Small Molecule Activation, Nuclear Chemistry and Related Spectroscopy
CYE924	Group theory, applied electrochemistry and X-ray structure analysis
CYS952	Environmental Sample Analysis
CYE931	Application of some important reactions in synthetic organic chemistry
CYE932	Natural Products and Drug Design
CYE933	Bioorganic Chemistry
CYE934	Advanced Stereochemistry and structure activity Correlation
CYS953	Multi Step Synthesis and characterization of Organic Compounds

CURRICULUM AND SYLLABUS FOR INTEGRATED MSC IN CHEMISTRY

DETAILED SYLLABUS
FIRST SEMESTER

Semester - I							
Sl. No	**Code**	**Subject**	**L**	**T**	**S**	**C**	**H**
1	MAC01	Mathematics - I	3	1	0	4.0	4
2	PHC01	Engineering Physics	2	1	0	3.0	3
3	CYC01	Engineering Chemistry	2	1	0	3.0	3
4	XEC01	Engineering Mechanics	2	1	0	3.0	3
5	ESC01	Environmental Science	2	0	0	2.0	2
6	XES51	Engineering Graphics	1	0	3	2.5	4
7	HSS51	Professional Communication Laboratory	1	0	2	2.0	3
8	PHS51	Physics Laboratory	0	0	2	1.0	2
9	CYS51	Chemistry Laboratory	0	0	2	1.0	2
10	WSS51	Workshop Practice	0	0	3	1.5	3
11	XXS51	Co-curricular Activities - I	0	0	2	1.0	2
		TOTAL	13	4	14	24.0	31

Department of Mathematics							
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	
MAC 01	MATHEMATICS - I	PCR	3	1	0	4	4
Pre-requisites		Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))					
Basic concepts of function, limit, differentiation, and integration.		CT+MT+EA					
Course Outcomes	• CO1: To introduce the fundamentals of differential calculus of single and several variables • CO2: To develop the basic concepts of integral calculus including multiple integrals and its application in finding area, volume, centre of mass, centre of gravity etc. • CO3: To introduce the fundamental concepts of vector calculus • CO4: To develop the concept of convergence						
Topics Covered	**Functions of Single Variable:** Rolle's Theorem and Lagrange's Mean Value Theorem (MVT), Cauchy's MVT, Taylor's and Maclaurin's series, Asymptotes & Curvature (Cartesian, Polar form). (8) **Functions of several variables:** Function of two variables, Limit, Continuity and Differentiability, Partial derivatives, Partial derivatives of implicit function, 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), Stationary points,						

	Lagrange's method of multipliers. (10) **Sequences and Series:** Sequences, Limit of a Sequence and its properties, Series of positive terms, Necessary condition for convergence, Comparison test, D Alembert's ratio test, Cauchy's root test, Alternating series, Leibnitz's rule, Absolute and conditional convergence. (6) **Integral Calculus:** Mean value theorems of integral calculus, Improper integral and it classifications, Beta and Gamma functions, Area and length in Cartesian and polar co-ordinates, Volume and surface area of solids of revolution in Cartesian and polar forms. (12) **Multiple Integrals:** Double integrals, Evaluation of double integrals, Evaluation of triple integrals, change of order of integration, Change of variables, Area and volume by double integration, Volume as a triple integral. (10) **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 applications. (10)
Text Books, and/or reference material	**Text Books:** 1. E. Kreyszig, Advanced Engineering Mathematics: 10th ed., Wiley India Ed. (2010). 2. Daniel A. Murray, Differential, and Integral Calculus, Fb & c Limited, 2018. 3. Marsden, J. E; Tromba, A. J.; Weinstein: Basic Multivariable Calculus, Springer, 2014. **Reference Books:** 1. Tom Apostal, Calculus-Vol-I & II, Wiley Student Edition, 2011. 2. Thomas and Finny: Calculus and Analytic Geometry, 11th Ed., Addison Wesley.

Mapping of CO (Course outcome) and PO (Programme Outcome)

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	
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					

CURRICULUM AND SYLLABUS FOR INTEGRATED MSC IN CHEMISTRY

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, etc. [8] **Wave Motion** - Wave equation, Longitudinal waves, Transverse waves, Electro-magnetic waves. [3] **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] **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] **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] **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]
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

CURRICULUM AND SYLLABUS FOR INTEGRATED MSC IN CHEMISTRY

Mapping of CO (Course outcome) and PO (Programme Outcome)

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	
CYC 01	Engineering Chemistry	PCR	2	1	0	3	3
Pre-requisites		Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))					
None		CT+MT+EA					
Course Outcomes	• CO1: Introduced to chemical thermodynamics, kinetics, electrochemistry, absorption, and catalytic processes for engineering applications • CO2: To learn fundamentals of polymer chemistry and petroleum engineering. • CO3: Introduced to basic spectroscopic techniques for structure determination and characterization. • CO4: To study few inorganic and bioinorganic compounds of industrial importance.						
Topics Covered	**ORGANIC CHEMISTRY** i. Fundamentals of organic reaction mechanisms; Few important reactions and their mechanism along with their applications; Robinson annulation, Hydroboration reaction, Organometallic reagents (Gilman reagents), Metathesis using Grubb's catalyst and Wittig reaction. (3) ii. Fundamental concept on stereochemistry and application: Conformation and configuration of organic compounds, Diastereo-selective, enantio-selective, regio-selective, stereo-specific, and stereo-selective reactions. (3) iii. Polymer chemistry and polymer engineering: Fundamental concept on polymer chemistry; synthesis and application of important polymers, Rubber, and plastic materials. Conducting polymer. (2) iv. Petroleum Engineering and oil refinery: origin of mineral oils, separation principle and techniques of distillation of crude oil, Uses of different fractions, octane number, cetane number, Knocking, anti-knock compounds, and Bio-Fuel. (2) v. Structure elucidation of organic compounds by modern spectroscopic methods; Application of UV-Visible and FT-IR spectroscopy. (3) **INORGANIC CHEMISTRY** i. **Coordination Chemistry:** Crystal Field Theory of octahedral and tetrahedral complexes, colour and magnetic properties, Jahn-Teller distortion, pseudo Jahn-Teller distortion, Isomerism, and stereochemistry. (5)						

	ii. **Bioinorganic Chemistry:** Heme and non-heme O_2 transport protein (Haemoglobin, Myoglobin), Chlorophyll and photosynthesis. (3) iii. **Inorganic Materials:** Introduction towards industrially important inorganic materials like cementing material, refractory material, fertiliser, inorganic polymer. (2) iv. **Organometallic Chemistry:** π-acid ligands, stabilization of metal low oxidation state and 18 electron rules, metal carbonyls and nitrosyls, metal-alkene complexes. (4) **PHYSICAL CHEMISTRY** i. **Thermodynamics:** 2nd law of thermodynamics, entropy, free energy, Gibbs Helmholtz equation, change of phase. Cryogenics: joule Thomson experiment. (4) ii. **Chemical Kinetics:** 2nd and 3rd order rate expression, Reversible reaction, Chain reaction, Consecutive reaction, Temp effect on reaction rate. (4) iii. **Electrochemistry:** Electrochemical cell, Effect of pH, precipitation, and complex formation on EMF of oxidation/reduction processes. (2) iv. **Absorption:** Physical and Chemical absorption, Absorption isotherms. (1) v. **Catalysis:** Types of catalysis, Rate expression for Catalysed reaction, Acid-base and Enzyme catalysis. (2)
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 CO (Course outcome) and PO (Programme Outcome)

Course	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CYC 01	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)

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	
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] 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] 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] Coefficients of static and kinetic friction; problems involving friction; theories of friction on square threaded power screw and flat belt. [5] Simple trusses; analysis of trusses by method of joints and method of sections. [5] 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] Path, velocity, acceleration; rectilinear and curvilinear motion; motion of system of particles; introduction to the concept of plane kinematics of rigid bodies. [6] 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] Principle of Virtual Work, Solution of Problems on Mechanics using Principle of Virtual Work [3]						
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 CO (Course outcome) and PO (Programme Outcome)

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	
ESC01	**Environmental Science**	PCR	2	0	0	2	2
Pre-requisites		Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))					
		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	**Introduction:** Multidisciplinary nature of Environmental Studies; Basic issues in Environmental Studies. [2] Human population and the Environment. [1] Social issues and the Environment. [1] **Constituents of our Environment & the Natural Resources:** Atmosphere– its layers, their characters; Global warming, Ozone depletion, Acid rain, etc. [5] Hydrosphere - Its constituents, Oceans, Groundwater, Surface waters; Hydrological cycle. [4] Lithosphere - constituents of lithosphere; Rock and Mineral resources; Plate Tectonic Concept and its importance. [5] Biosphere– its components; Ecosystems and Ecology; Biodiversity; Biomes. [5] Natural disaster and their management – Earthquakes, Floods, Landslides, Cyclones. [3] **Pollution:** Pollutants and their role in air and water pollution. [2]						
Text Books, and/or reference material	1. Environmental Studies – Benny Joseph – Tata McgrawHill-2005 2.Environmental Studies – Dr. D.L. Manjunath, Pearson Education-2006. 3.Principles of Environmental Science and Engineering – P. V. Rao, PHI. 4. Environmental Science and Engineering – Meenakshi, Prentice Hall India. 5.Environmental studies – R. Rajagopalan – Oxford Publication - 2005. 6. Text book of Environmental Science & Technology – M. A. Reddy – BS Pub.						

CURRICULUM AND SYLLABUS FOR INTEGRATED MSC IN CHEMISTRY

Mapping of CO (Course outcome) and PO (Programme Outcome)

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	
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. [6] 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. [9] 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] Projection of simple regular solids, viz. prisms, cubes, cylinders, pyramids, cones, tetrahedrons, spheres, hemi-spheres etc. [6] Section of solids; section by perpendicular planes; sectional views; true shapes of sections. [6] Dimensional techniques; international and national standards (ISO and BIS). [3] Freehand graphics. [3]						
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						

CURRICULUM AND SYLLABUS FOR INTEGRATED MSC IN CHEMISTRY

Mapping of CO (Course outcome) and PO (Programme Outcome)

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	
HSS51	Professional Communication Lab	PCR	1	0	2	3	2
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
None		CT+EA					

Course Outcomes	• CO1: Improvement in linguistic proficiency of the learners • CO2: Improvement in communicative ability of the learners • CO3: Improvement in social connectivity skill
Topics Covered	1. Professional Communication: Introduction (1) 2. Technical Writing: Basic Concepts (2) 3. Style in Technical Writing (3) 4. Technical Report (2) 5. Recommendation Report (2) 6. Progress Report (1) 7. Technical Proposal (3) 8. Business Letters (3) 9. Letters of Job Application (2) 10. Writing Scientific and Engineering Papers (3) 11. Effective Use of Graphic Aids (2) 12. Presentation Techniques (6) 13. Group Discussion (6) 14. Interview Techniques (6)
Text Books, and/or reference material	**Text Book:** 1. English for Engineers –Sudharshana& Savitha (Cambridge UP) **Reference Books:** 1. English for Engineers -Sudharshana & Savitha (Cambridge UP) 2. Effective Technical Communication-M A Rizvi (McGraw Hill Education) 3. References to relevant NPTEL, MOOC, SWAYAM courses be given by the Instructor

CURRICULUM AND SYLLABUS FOR INTEGRATED MSC IN CHEMISTRY

Mapping of CO (Course outcome) and PO (Programme Outcome)

Course	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
HSS51	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	
PHS51	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 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 CO (Course outcome) and PO (Programme Outcome)

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)

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	
CYS51	**CHEMISTRY LABORATORY**	PCR	0	0	2	2	1
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
None		CT+EA					
Course Outcomes	• CO1: To learn basic analytical techniques useful for engg 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	i. Experiments based on pH metry: Determination of dissociation constant of we acids by pH meter. ii. Experiments based on conductivity measurement: Determination of amou of HCl by conductometric titration with NaOH. iii. Estimation of metal ion: Estimation of Fe^{2+} by permangnomentry iv. Estimation of metal ion: Determ. of total hardness of water by EDTA titration. v. Synthesis and characterization of inorganic complexes: e. g. $Mn(acac)_3$, Fe(acac cis-bis(glycinato)copper (II) monohydrate and their characterization by m. p FTIR etc. vi. Synthesis and charact. of organic compounds: e.g.Dibenzylideneacetone. vii. Synthesis of polymer: polymethylmethacrylate viii. Verification of Beer-Lamberts law and determination of amount of iron prese in a supplied solution. ix. Chromatography: Separation of two amino acids by paper chromatography x. Determination of saponification value of fat/ vegetable oil						
	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: 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 CO (Course outcome) and PO (Programme Outcome)

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)

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	
WSS51	**WORKSHOP PRACTICE**	PCR	**0**	**0**	**3**	**3**	**1.5**
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
NIL		CT+EA					

Course Outcomes	• CO1: Study and practice on machine tools and their operations • CO2: Practice on manufacturing of components using workshop trades including fitting, carpentry, foundry and welding • CO3: Identify and apply suitable tools for machining processes including turning, facing, thread cutting and tapping • CO4: Develop basic electrical engineering knowledge for house wiring practice
Topics Covered	**M/c shop & Carpentry shop -- 3X3= 9hrs.** • Introduction on machining process. • Introduction to machine tools- Lathe, Shaper, Milling and Drill machine. • Introduction to woods- Types, structure, disease and defect of wood. • Introduction to wood working machines and tools. • Making of dovetail joint and bridle joint. **Welding Shop & Sheet metal -- 3X3= 9hrs.** • Introduction to welding.Safety and precautions in welding. • Formation of weld bead by SMAW on mild steel flat. • Formation of weld bead by oxy-fuel welding on mild steel flat. • Introduction to sheet Metal works. • Tools and Machines used in sheet metal works. • Concept of development, marking out of metal sheets. • Cutting and joining of metal sheets. • Safety precautions, General warning needed in the shop floor. **Black smithy & Foundry -- 3X3= 9hrs.** • Introduction Smithing and Forging- Tools, Machines, Furnaces and its accessories, fuels. • Safety and precautions in blacksmithy. • Making of bars of different cross-sections. • Making of hexagonal headed bolts. • Forge welding. • Introduction to Foundry Technology. • Preparation of sand mould using Solid/Split Pattern. **Fitting & Electrical shop -- 3X3= 9hrs.** • Introduction to hand metal cutting tools with specifications, nomenclature and their use. • Marking tools, measuring tools and their use.

	• Fitting of joints of mild steel flats. • Introduction to electrical hazards and safety precaution. • Wire jointing and soldering. • PVC Conduit Wiring controlled by separate single way switches. • PVC Cashing Capping Wiring for two-way switches. • Conduit wiring for the connection of a Calling Bell with In& Out Indicators. • Batten Wiring and Cleat Wiring. • Tube Light Connection. • Insulation Resistance Testing of 1ph / 3ph Motor and House Wiring. • Earth Resistance Testing. • DOL Starter Connection. **Viva voce -- 1X3= 3hrs.**
Text Books, and/or reference material	1. Workshop Technology Part I and Part II by W. A. J. Chapman 2. Elements of Workshop Technology S. K. Hazra Chowdhury, A. K. Hazra Chowdhury and Nirjhar Roy 3. Mechanical Workshop Practice by K. C. John

Mapping of CO (Course outcome) and PO (Programme Outcome)

Course	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
WSS51	CO1	2	-	-	-	-	1	-	-	-	1	-	-
	CO2	1	-	1	-	-	1	-	-	-	1	-	-
	CO3	1	-	2	-	-	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	
XXS-51	**Co-curricular 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: Ethics: Recognize different value systems including your own, understand the moral dimensions of your decisions, and accept responsibility for them • CO3: Self-directed and Life-long Learning: Acquire the ability to engage in independent and life-long learning in the broadest context socio-technological changes. • CO4: Personality development through community engagement • CO5: Exposure to social service
Topics Covered	**YOGA** • Introduction of Yoga. • Sitting Posture/Asanas- Padmasana, Vajrasana, Ardhakurmasana, Ustrasana,

	Bakrasana, Sasankasana, Janusirshasana, Suryanamaskar. • Mudra- Gyana mudra, Chin mudra, Shuni mudra, Prana mudra, Adi mudra, Anjali mudra. • Laying Posture/Asanas- PavanaMuktasana, UttanaPadasana, Sarpasana, Bhujangasana (Cobra Pose), Eka Pada Śalabhāsana, Dhanurasana, Chakrasana, Viparitkarani. • Meditation- Yognidra, Om chant, Pray chant. • Standing Posture/Asanas- Tadasana (Mountain Pose), Vrikshasana (Tree Pose), Ardhachandrasana, Trikonasana, Utkatasana, Padahastasana. • Pranayama- Deep breathing, AnulomVilom, Suryabhedi, Chandrabhedi. • Kriya- Kapalbhati, Trataka. **ATHLETICS** • Introduction of Athletic. • Starting Technique for Track events- Standing start, Crouch & Block start. • Finishing Techniques. • Relay Race- 4×100m, 4×400m & Baton Exchange Technique & Rules. • Track Marking with Fundamentals- 200m, 400m and Diagonal Distance Radius, Straight Distance, Staggers of Different Lanes & Curve Distance. **BASKETBALL** • Introduction and Players stance and ball handling. • Passing- Two hand chest pass, two hand bounce pass, One hand baseball pass, Side arm pass, Overhead pass, Hook pass. • Receiving- Two hand receiving, one hand receiving, receiving in stationary position, Receiving while jumping and Receiving while running. • Dribbling- Dribble, High dribble, Low dribble, Reverse dribble, Rolling dribble. • Rules of Basketball. • Basketball game. **VOLLEYBALL** • Introduction of Volleyball • Service- Underarm service, Sidearm service, Tennis service, Floating service, Jump service. • Pass: Underarm pass- Ready position, Teaching stage of underarm pass and Upper hand pass- Volley pass, Back pass, Short set, Jump set & Underarm set. • Rules and their interpretation. **FOOTBALL** • Introduction of Football • Push pass- Instep inside, Instep outer side. • Kicking- Spot kick, Instep kick, Lofted kick. • Dribbling- One leg, Both legs, Instep. • Trapping- Rolling ball sole trapping, High ball sole trapping, High ball chest trapping, High ball thigh trapping. • Throwing- Standing throw, Running throw, Seating throw. • Goal Keeping- Griping the ball, Full volley, Half volley, Drop Kick.

	• Rules and their interpretation. **CRICKET** • Introduction of Cricket • Batting gripping & Stance, Bowling gripping technique. • Batting front foot defense& Drive. • Batting Back foot defense& Drive. • Batting Square cut. • Bowling medium pace, Bowling off break. • Fielding drill, Catching (Short & High). • Rules & Regulation. **BADMINTON** • Basic introduction about Badminton and Badminton court. • Racket parts, Racket Grip, Shuttle Grip. • Basic stance, Basic Footwork, Shadow practice (Full court movement). • Strokes services: Forehand- Overhead & Underarm, Backhand- Overhead & Underarm. • Match practice (Single & Double). • Rules & Regulation. **TABLE TENNIS** • Introduction of Table Tennis. • Basic Stance and Grip (Shake hand & Pen hold). • Service Basic. • Stroke: Backhand- Push, Deep Push, Chop, Rally, Drive, Drop Shot, Flick, Block, Smash. • Stroke: Forehand- Push, Deep Push, Chop, Rally, Drive, Drop Shot, Flick, Block, Smash. • Rules and their interpretations. • Table Tennis Match (Singles & Doubles). **NCC** • FD-1 General Introduction and words of command. • FD-2 Attention, Stand at ease and Stand easy, Turning and inclining at the halt. • FD-3 Sizing, Forming up in three Ranks Numbering, Open and Close order March and Dressing. • FD-4 Saluting at the halt, Getting on parade, Dismissing and falling out. • FD-5 Marching, Length of pace and Time of Marching in quick time and Halt, Slow March and Halt. • FD-7 Turning on the March and Wheeling. • FD-12 Parade practice. **TAEKWONDO** • Introduction about Taekwondo- Meaning of Taekwondo, Korean language of dress, Fighting area, Punch, Block, Kicks etc. • Stance- Ready stance, Walking stance, Fighting stance, Front stance, Back stance, Cat stance etc. • Punch Technique- Front fist punch, Rear fist punch, Double fist punch, With

	stance etc. Blocks- Upper blocks, Middle block, Side block, Suto etc. • Foot Technique (Balgisul)- Standing kick (Saseochagi), Front kick (Abchagi), Doliyo (Chagi), Abdalchagi (Butterfly kick), Back kick etc. **NSS** • Swachha Bharat Mission • Free Medical Camp • Sanitation drive in and around the campus. • Unnat Bharat Abhiyaan • MatribhashaSaptah celebration

Mapping of CO (Course outcome) and PO (Programme Outcome)

Course	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
XXS51	CO1	-	-	-	-	-	2	-	-	3	-	-	-
	CO2	-	-	-	-	-	-	-	2	-	-	-	-
	CO3	-	-	-	-	-	-	1	-	-	-	-	3
	CO4	-	-	-	-	-	-	-	-	2	2	-	-
	CO5	-	-	-	-	-	3	1	-	-	-	-	-

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

SECOND SEMESTER

Sl. No	Code	Subject	L	T	S	C	H
1	MAC02	Mathematics - II	3	1	0	4.0	4
2	CSC01	Introduction to Computing	2	1	0	3.0	3
3	ECC01	Basic Electronics	2	1	0	3.0	3
4	EEC01	Electrical Technology	2	1	0	3.0	3
5	BTC01	Life Science	2	0	0	2.0	2
6	XXC01	The Constitution of India and Civic Norms	1	0	0	1.0	1
7	XES52	Graphical Analysis using CAD	0	0	2	1.0	2
8	CSS51	Computing Laboratory	0	0	2	1.0	2
9	ECS51	Basic Electronics Laboratory	0	0	2	1.0	2
10	EES51	Electrical Technology Laboratory	0	0	2	1.0	2
11	XXS52	Co-curricular Activities - II	0	0	2	1.0	2
		TOTAL	12	4	10	21.0	26

<table>
<tr><td colspan="7">Department of Mathematics</td></tr>
<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>Credit</td></tr>
<tr><td>Lecture (L)</td><td>Tutorial (T)</td><td>Practical (P)</td><td>Total Hours</td><td></td></tr>
<tr><td>MAC 02</td><td>MATHEMATICS - II</td><td>PCR</td><td>3</td><td>1</td><td>0</td><td>4</td><td>4</td></tr>
<tr><td colspan="3">Pre-requisites</td><td colspan="4">Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))</td></tr>
<tr><td colspan="3">Basic concepts of set theory, differential equations, and probability.</td><td colspan="4">CT+MT+EA</td></tr>
<tr><td>Course Outcomes</td><td colspan="6">• CO1: Develop the concept of basic linear algebra and matrix equations so as to apply mathematical methods involving arithmetic, algebra, geometry to solve problems.
• CO2: To acquire the basic concepts required to understand, construct, solve and interpret differential equations.
• CO3: Develop the concepts of Laplace transformation & Fourier transformation with its property to solve ordinary differential equations with given boundary conditions which are helpful in all engineering & research work.
• CO4: To grasp the basic concepts of probability theory.</td></tr>
</table>

Topics Covered	**Elementary algebraic structures:** Group, subgroup, ring, subring, integral domain, and field. (5) **Linear Algebra:** Vector space, Subspaces, Linear dependence and independence of vectors, Linear span, Basis and dimension of a vector space. Rank of a matrix, Elementary transformations, Matrix inversion, Solution of system of Linear equations, Eigen values and Eigen vectors, Cayley-Hamilton Theorem, Diagonalization of matrices. (15) **Ordinary Differential Equations:** Existence and uniqueness of solutions of ODE (Statement Only), Equations of first order but higher degree, Clairaut's equation, Second order differential equations, Linear dependence of solutions, Wronskian determinant, Method of variation of parameters, Solution of simultaneous equations. (12) **Fourier series:** Basic properties, Dirichlet conditions, Sine series, Cosine series, Convergence. (4)
	Laplace and Fourier Transforms: Laplace transforms, Inverse Laplace transforms, Convolution theorem, Applications to Ordinary differential equations. Fourier transforms, Inverse Fourier transform, Fourier sine and cosine transforms and their inversion, Properties of Fourier transforms, Convolution. (10) **Probability:** Historical development of the subject and basic concepts, Axiomatic definition of probability, Examples to calculate probability, Random numbers. Random variables and probability distributions, Binomial distribution, Normal distribution. (10)
Text Books, and/or reference material	**Text Books:** 1. E. Kreyszig, Advanced Engineering Mathematics: 10thed, Wiley India Ed. (2010). 2. Gilbert Strang, Linear algebra and its applications (4th Ed), Thomson (2006). 3. Shepley L. Ross, Differential Equations, 3rd Edition, Wiley Student Ed (2017). **Reference Books:** 1. S. Kumaresan, Linear algebra - A Geometric approach, PHI (2000). 2. C. Grinstead, J. L. Snell, Introduction to Probability, American Math. Society.

Mapping of CO (Course outcome) and PO (Programme Outcome)

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)

CURRICULUM AND SYLLABUS FOR INTEGRATED MSC IN CHEMISTRY

<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>CSC01</td><td>INTRODUCTION TO COMPUTING</td><td>PCR</td><td>2</td><td>1</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 (CT), mid-term (MT) and end assessment (EA))</td></tr>
<tr><td colspan="2">Basic knowledge of computer.</td><td colspan="6">CT+MT+EA</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">CO1: Recognize the changes in hardware and software technologies with respect to the evolution of computers and describe the function of system software's (operating Systems) and application software's, languages, number system, logic gates.
CO2: Illustrate the flowchart and inscribe an algorithm for a given problem Inscribe C programs using operators.
CO3: Develop conditional and iterative statements to write C programs.
CO4: Exercise user defined functions to solve real time problems
CO5: Inscribe C programs that use Pointers to access arrays, strings and functions.
CO6: Exercise user defined data types including structures and unions to solve problems.</td></tr>
<tr><td>Topics Covered</td><td colspan="7">Fundamentals of Computer: History of Computer, Generation of Computer, Classification of Computers 2L Basic Anatomy of Computer System, Primary & Secondary Memory, Processing Unit, Input & Output devices. [2]
Languages: Assembly language, high level language, compiler, and assembler (basic concepts) [1]
Binary & Allied number systems representation of signed and unsigned numbers. BCD, ASII. Binary Arithmetic & logic gates. [2]
Basic concepts of operating systems like MS DOS, MS WINDOW, UNIX, Algorithm & flow chart. [1]
C Fundamentals: The C character set identifiers and keywords, data type & sizes, variable names, declaration, statements. [2]
Operators & Expressions: Arithmetic operators, relational and logical operators, type, conversion, increment and decrement operators, bit wise operators, assignment operators and expressions, precedence, and order of evaluation. Input and Output: Standard input and output, formatted output -- printf, formatted input scanf. [8]
Flow of Control: Statement and blocks, if - else, switch, loops - while, for do while, break and continue, go to and labels. [5]
Fundamentals and Program Structures: Basic of functions, function types, functions returning values, functions not returning values, auto, external, static and register Variables, scope rules, recursion, function prototypes, C pre-processor, command line arguments. [5]
Arrays and Pointers: One-dimensional, two-dimensional arrays, pointers and functions, multi-dimensional arrays. [10]
Structures Union and File: Structure, union, structures and functions, arrays of structures, file read, file write.[5]</td></tr>
</table>

CURRICULUM AND SYLLABUS FOR INTEGRATED MSC IN CHEMISTRY

Text Books, and/or reference material	Text Books: 1. Let us C by Kanetkar 2. C Programming by Gottfried 3. Introduction to Computing by Balaguruswamy 4. The C-programming language by Dennis Ritchie Reference Books: 1. Computer fundamental and programming in C by P Dey and M. Ghosh 2. Computer fundamental and programming in C by Reema Thareja 3. programming with C by Schaum Series

Mapping of CO (Course outcome) and PO (Programme Outcome)

Course	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CSC01	CO1	3	1	2	1	-	-	-	-	-	-	-	-
	CO2	-	2	1	2	1	-	-	-	-	-	-	-
	CO3	1	2	-	-	3	-	-	-	-	-	-	-
	CO4	1	3	1	2	3	-	-	-	-	-	-	1
	CO5	2	1	-	-	3	-	-	-	-	-	-	-
	CO6	2	-	3	-	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	
ECC01	**Basic Electronics**	PCR	2	1	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: Knowledge of Semiconductor physics and devices. • CO2: Have an in depth understanding of basic electronic circuit, construction, operation. • CO3: Ability to make proper designs using these circuit elements for different applications. • CO4: Learn to analyze the circuits and to find out relation between input and output.						
Topics Covered	1. **Semiconductors** 1.1. Concept of band formation in solids; Fermi-Dirac distribution function, concept of Fermi level, invariance of Fermi level in a system under thermal equilibrium 1.2. Definitions of insulator, conductor and semiconductor using band diagram 1.3. Crystalline structure of semiconductor 1.3.1. Covalent bond						

	1.3.2. Generation of holes and electrons 1.3.3. Effect of temperature on semiconductor 1.4 Intrinsic semiconductor 1.5 Doping and Extrinsic semiconductor 1.5.1 n-Type semiconductor and band diagram 1.5.2 p-Type semiconductor and band diagram 1.5.3 Mass-action law of semiconductor 1.6. Conductivity of semiconductor (including mathematical expression) 1.7 Carrier transport phenomenon. (03 hrs.) 2. **Diodes** 2.1. Construction 2.2. Unbiased diode; Depletion layer and Barrier potential; junction capacitance (expression only) 2.3. Principle of operation with forward biasing and reverse biasing 2.4. Characteristics 2.5 Diode's three models/equivalent circuits.(02 hrs.) 3.**Diode Circuits** 3.1 Diode rectifier 3.1.1 Half wave rectifier 3.1.2 Full wave rectifier:centre tap and bridge rectifier 3.1.3 Capacitive filter and DC power supply (Numerical problems) 3.2 Special Diodes 3.2.1 Zenerdiode: Avalanche breakdown and Zener breakdown and characteristics. 3.2.2 Zener diode as a voltage regulator 3.2.3 Displaydevices: LED and LCD. (03 hrs.) 4.**Bipolar Junction Transistor (BJT)** 4.1 n-p-n and p-n-p transistor and their constructions 4.2 Principle of operation 4.3 Transistor configuration: common base, common emitter, and common collector 4.4 Transistor characteristics: input and output characteristics of CB and CE configurations 4.5 DC load line: quiescent (Q) point; cut-off, active, and saturation region 4.6 Amplifier: Principle of operation 4.7 Transistor as a switch. (04 hrs.) 5.**Transistor Biasing** 5.1 Need of biasing 5.2 Methods of biasing: base resistor or fixed bias, emitter feedback, voltage divider biasing 5.3 Stability of Q-point (qualitative discussions) 5.4 (Numerical problems). (02 hrs.) 6.**Single Stage Amplifier:** classification of amplifiers (voltage amplifier, current amplifier, power amplifier etc.) Class-A CE Amplifier with coupling and bypass capacitors, Qualitative discussions of magnitude characteristics of frequency response (graph only) (02 hrs.)

	7.**Feedback Amplifier** 7.1 Positive and negative feedback 7.2 Deduction of gain with negative feedback, explanation of stability of gain with negative feedback, other effects of negative feedback (no deduction), numerical problems. (03 hrs.) 8.**Other Semiconductor Devices** 8.1 JFET: Construction, principle of operation, characteristics 8.2 MOSFET: Construction, principle of operation, characteristics 8.3 Power Electronic Device-SCR: Brief discussions. (02 hrs.) 9.**Operational Amplifier** 9.1 Characteristics of ideal operational amplifier 9.2 Pin Configuration of IC 741, 9.3 Analysis of simple operational amplifier circuits: concept of virtual ground; noninverting amplifier and inverting amplifier. 9.4 Applications: voltage follower, summer, differentiator, integrator, and comparator (04 hrs) 10.**Oscillator** 10.1 Positive feedback and condition of oscillation 10.2 R-C phase-shift oscillator, Wien bridge oscillator.(02 hrs.) 11.**Boolean Algebra** 11.1 Boolean algebra, De Morgan's theorem, simplification of Boolean expressions 11.2 Number system, range extension of numbers, overflow 11.3 Different codes: gray code, ASCII code and BCD codes and them Applications. (01 hrs.) 12. **Logic Gates** 12.1 NOT, OR, AND, NOR, NAND, EX-OR, EX-NOR gates 12.2 Simplification of logic functions 12.3 Realizations of logic expressions using logic gates. (01 hrs.) 13. CRO and its applications and other test and measurement instruments. (01 hrs.)
Text Books, and/or reference material	Text Books: 1. Introduction Electronic Devices & Circuit Theory,11/e, 2012, Pearson: Boylestad & Nashelsky 2. Electronic Principles, by Albert Paul MalvinoDr. and David J. Bates, 7/e. Reference Books: 1. Integrated Electronics by Millman, Halkias and Parikh, 2/e, McGrawHill. 2. ELECTRONICS Fundamentals and Applications by Chattopadhyay and Rakshit,15/e, New Age Publishers. 3. The Art of Electronics by Paul Horowitz, Winfield Hill, 2/e, Cambridge University. 4. Electronics - Circuits and Systems by Owen Bishop, 4/e, Elsevier. 5. Electronics Fundamentals: Circuits, Devices & Applications by Thomas L. Floyd & David M. Buchla, 8/e, Pearson Education.

CURRICULUM AND SYLLABUS FOR INTEGRATED MSC IN CHEMISTRY

Mapping of CO (Course outcome) and PO (Programme Outcome)

Course	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
ECC01	CO1	2	3	2	2	-	1	-	-	-	-	-	1
	CO2	3	2	1	2	2	1	-	2	2	-	-	1
	CO3	3	2	2	2	3	-	-	-	2	-	-	1
	CO4	3	3	2	2	-	-	-	-	2	-	-	1

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

<table>
<tr><td colspan="7">Department of Electrical Engineering</td></tr>
<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>EEC01</td><td>ELECTRICAL TECHNOLOGY</td><td>PCR</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="5">Course Assessment methods (Continuous (CT), Mid Term (MT), and end assessment (EA))</td></tr>
<tr><td colspan="2">NIL</td><td colspan="5">CT+MT+ EA</td></tr>
<tr><td>Course Outcomes</td><td colspan="6">Upon successful completion of this course, the student should be able to
• CO1: learn the fundamentals of Electric Circuits and Network theorems and analysis of electrical network based on these concepts.
• CO2: develop an idea on Magnetic circuits, Electromagnetism and learning the working principles of some fundamental electrical equipment’s
• CO3: learn about single phase and poly-phase AC circuits and analysis of such circuits based on these concepts.
• CO4: introduce the basic concept of single-phase transformer.
• CO5: analyze the transient phenomena in electrical circuits with DC excitation.</td></tr>
</table>

Topics Covered	Introduction: Overview of Electrical power generation systems (2) Fundamentals of Electric Circuits: Ohm's laws, Kirchhoff's laws, Independent and Dependent sources, Analysis of simple circuits. (4) Network theorems: Superposition Theorem, Thevenin's Theorem, Norton's Theorem, Maximum Power Transfer Theorem (4) Magnetic circuits: Review of fundamental laws of electromagnetic induction, transformer and rotational emfs, Solution of magnetic circuits. Analysis of coupled circuits (self-inductance, mutual inductance, and dot convention)(8) Transients with D.C. excitation for R-L and R-C circuits. (3) 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, Behavior of A.C. circuits, Resonance in series and parallel R-L-C circuits. AC Network: Superposition theorem, Thevenin's theorem, Norton's theorem, maximum power transfer theorem, solution of networks with AC sources. (10) Single-Phase Transformer, equivalent circuits, open circuit and short circuit tests (6) 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, Power measurement in 3-phase circuits. (5)
Textbooks/Reference material	Textbooks: 1. Electrical & Electronic Technology by Hughes, Pearson Education India Reference Books: 1. Advanced Electrical Technology by H. Cotton, Reem Publication Pvt. Ltd 2. Electrical Engineering fundamentals by Vincent Deltoro, Pearson Edu India

Mapping of CO (Course Outcome) and PO (Programme Outcome)

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

Correlation levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

CURRICULUM AND SYLLABUS FOR INTEGRATED MSC IN CHEMISTRY

<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>BTC01</td><td>LIFE SCIENCE</td><td>PCR</td><td>2</td><td>0</td><td>0</td><td>2</td><td>2</td></tr>
<tr><td colspan="2">Pre-requisites</td><td colspan="6">Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))</td></tr>
<tr><td colspan="2"></td><td colspan="6">CT+MT+EA</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">CO1: Basic understanding of basic cellular organization of organisms and cellular communications, structure and functions of the macromolecules and their biosynthesis and cata--bolism.
CO2: To give an understanding of the key features of the structure, growth, physiology and behavior of bacteria, viruses, fungi and protozoa
CO3: To introduce molecular biology to understand biological processes in various applications.
CO4: To provide a foundation in immunological processes and an overview of the interaction between the immune system and pathogens.
CO5: To provide knowledge about biological and biochemical processes that require engineering expertise to solve them
CO6: To provide knowledge about biological and biochemical processes that require engineering expertise to solve them</td></tr>
<tr><td>Topics Covered</td><td colspan="7">1. Cell Biology (4)
a) Introduction to life science: prokaryotes & eukaryotes
Definition; Difference
b) Introduction to cells - Define cell, different types of cell
c) Cellular organelles - All organelles and functions in brief
d) Cellular communications
Introduction to basic signaling; endocrine, paracrine signaling; concepts of receptor, ligand, on-off switch by phosphorylation/dephosphorylation
2. Biochemistry (4)
a) Biological function of carbohydrate and lipid - Introduction, structure and function
b) Biological function of nucleic acids and protein - structure and function
c) Catabolic pathways of Macromolecules - Introduction to catabolism, hydrolysis and condensation reactions; Catabolism of glucose- Glycolysis, TCA; overall degradation of proteins and lipids
d) Biosynthesis of Macromolecules
Generation of ATP (ETS), Generation of Glucose (Photosynthesis)
3. Microbiology (5)
a) Types of microorganisms and their general features - Bacteria, Yeast, Fungi, Virus, Protozoa- general introduction with practical significance and diseases
b) Microbial cell organization - Internal and External features of cell- bacterial cell wall, viral capsule, pilus etc,
c) Microbial nutritional requirements and growth - Different Sources of energy; growth curve
d) Basic microbial metabolism - Fermentation, Respiration, Sulfur, N_2 cycle</td></tr>
</table>

	4. Immunology (5) a) Basic concept of innate and adaptive immunity - Immunity-innate and adaptive, differences, components of the immune system b) Antigen and antibody interaction - Antigen and antibody, immunogen, factors affecting immunogenicity, basic antigen-antibody mediated assays, introduction to monoclonal antibody c) Functions of B cell - B cell, antibody production, memory generation and principle of vaccination d) Role of T cell in cell-mediated immunity - Th and Tc, functions of the T cell with respect to different pathogen and cancer cell **5. Molecular Biology (5)** a) Prokaryotic Genomes (Genome organization & structure) - Nucleoid, circular or linear b) Eukaryotic Genomes (Genome organization & structure) - Intron, exon, packaging, chromatin c) Central Dogma (Replication, Transcription and Translation) d) Applications of Molecular Biology (Diagnostics, DNA-fingerprinting, Recombinant products etc.) - Introduction to Recombinant DNA, fingerprinting, cloning **6. Bioprocess Development (5)** a) Microbial growth kinetics - Batch, fed-batch and continuous systems, Monod Equation b) Enzyme kinetics, kinetics of enzyme inhibition and deactivation Definition of enzymes, activation energy, Concepts of Km, Vmax, Ki c) Microbial sterilization techniques and kinetics Introduction to sterilization, dry and moist sterilization d) Thermodynamics of biological system - Concepts of Enthalpy, Entropy, favorable reactions, exergonic and endergonic reactions e) Material and energy balance for biological reactions - Stoichiometry
Text Books, and/or reference material	1. Biotechnology 01 Edition, authored by U. Satyanarayana, BOOKS & ALLIED (P) LTD. 2. Biochemistry by Lehninger. McMillan publishers 3. Microbiology by Pelczar, Chan and Krieg, Tata McGraw Hill 4. Brown, T.A., Genetics a Molecular Approach, 4th Ed. Chapman and Hall, 1992 5. Kuby J, Thomas J. Kindt, Barbara, A. Osborne Immunology, 6th Edition, Freeman, 2002. 6. Bioprocess Engineering: Basic Concepts (2nd Ed), Shuler and Kargi, PHI.

Mapping of CO (Course outcome) and PO (Programme Outcome)

Course	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
BTC01	CO1	2	1	1	-	1	-	-	-	-	-	-	-
	CO2	2	1	1	-	1	-	1	-	-	-	-	-
	CO3	2	1	1	-	1	-	-	-	-	-	-	-
	CO4	2	1	1	-	1	-	-	1	-	-	-	1
	CO5	2	1	1	-	1	1	1	-	-	-	-	-

CURRICULUM AND SYLLABUS FOR INTEGRATED MSC IN CHEMISTRY

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	
XXC01	The Constitution of India and Civic Norms	PCR	1	0	0	1	1
Pre-requisites		Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))					
NIL		CT+MT+EA					
Course Outcomes	CO1: Elementary understanding of the evolution of historical events that led to the making of the Indian constitution, the philosophical values, basic structure and fundamental concerns enshrined in the Constitution of India. CO2: Aware of the fundamental rights and duties as a citizen of the country. CO3: Enable to know the civic norms to be followed according to the Indian constitution						
Topics Covered	**1.** Historical background of the Making of Indian Constitution (1 Hour) **2.** Preamble and the Philosophical Values of the Constitution (1 Hour) **3.** Brief Overview of Salient Features of Indian Constitution (1 Hour) **4.** Parts I & II: Territoriality and Citizenship (1 Hour) **5.** Part III: Fundamental Rights (2 Hours) **6.** Part IV: Directive Principles of State Policy (1 Hour) **7.** Part IVA: Fundamental Duties (1 Hour) **8.** Union Government: President, Prime Minister and Council of Ministers (2 Hours) **9.** Parliament: Council of States and House of the People (1 Hour) **10.** State Government: Governor, Chief Mister and Council of Ministers (1 Hour) **11.** State Legislature: Legislative Assemblies and Legislative Councils (1 Hour) **12.** Indian Judiciary: Supreme Court and High Courts (1 Hour) **13.** Centre-State Relations (1 Hour) **14.** Reservation Policy, Language Policy and Constitution Amendment (1 Hour)						
Text Books, and/or reference material	Primary Readings: 1) P. M. Bakshi, *The Constitution of India*, 18th ed. (2022) 2) Durga Das Basu, *Introduction to the Constitution of India*, 25th ed. (2021) 3) J.C. Johari, *Indian Government and Politics*, Vol. II, (2012) Secondary Readings: Granville Austin, *The Indian Constitution: Cornerstone of a Nation* (1966; paperback ed. 1999); Granville Austin, *Working a Democratic Constitution: The Indian Experience* (1999; paperback ed. 2003).						

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	
XES52	**GRAPHICAL ANALYSIS USING CAD**	PCR	0	0	2	2	1
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
NIL		CT+EA					
Course Outcomes	• CO1: Introduction to graphical solution of mechanics problems • CO2: Knowledge on graphical solution methods for solving equilibrium in coplanar force system • CO3: Introducing Maxwell diagram and solution of plane trusses by graphical method • CO4: Determination of centroid of plane figures by graphical method • CO5: Exposure to AutoCAD software for computer aided graphical solution						
Topics Covered	• Graphical analysis of problems on statics. [14] • Graphical solution of engineering problems using CAD (with the help of "AutoCAD") [14]						
Text and/or reference material	1)… Engineering Drawing and Graphics – K Venugopal 2)… AutoCAD — George Omura 3)… Practical Geometry and Engineering Graphics – W Abbott						

Mapping of CO (Course outcome) and PO (Programme Outcome)

Course	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
XES52	CO1	2	-	-	-	-	-	-	-	-	-	-	-
	CO2	1	2	-	-	-	-	-	-	-	-	-	-
	CO3	2	1	-	-	-	-	-	-	-	-	-	-
	CO4	2	1	-	-	-	-	-	-	-	-	-	-
	CO5	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	
CSS51	**COMPUTING LABORATORY**	PCR	0	0	2	2	1
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
NIL		CT+EA					
Course Outcomes	• CO1: To understand the principle of operators, loops, branching statements, function, recursion, arrays, pointer, parameter passing techniques						

	• CO2: To detail out the operations of strings • CO3: To understand structure, union • CO4: Application of C-programming to solve various real time problems
Topics Covered	**List of Experiments:** 1. Assignments on expression evaluation 2. Assignments on conditional branching, iterations, pattern matching 3. Assignments on function, recursion 4. Assignments on arrays, pointers, parameter passing 5. Assignments on string using array and pointers 6. Assignments on structures, union
Text Books, and/or reference material	**Text Books:** 1. Let us C by Kanetkar 2. C Programming by Gottfried 3. Introduction to Computing by Balaguruswamy 4. The C-programming language by Dennis Ritchie **Reference Books:** 1. Computer fundamental and programming in C by P Dey and M. Ghosh 2. Computer fundamental and programming in C by Reema Thareja 3. programming with C by Schaum Series

Mapping of CO (Course outcome) and PO (Programme Outcome)

Course	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CSS51	CO1	3	-	1	-	-	-	-	-	-	-	-	-
	CO2	-	2	1	3	-	-	-	-	-	-	-	-
	CO3	-	1	-	2	1	-	-	-	-	-	-	-
	CO4	-	-	3	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	
ECS 51	**Basic electronics Lab**	PCR	0	0	2	2	1
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
NIL		CT+EA					
Course Outcomes	• CO1: Acquire idea about basic electronic components, identification, and behavior. • CO2: To determine IV characteristics of these Circuit elements for different applications. • CO3: Learn to analyze the circuits and observe and relate input and output signals.						

Labs Conducted.	1. To know your laboratory: To identify and understand the use of different electronic and electrical instruments. 2. To identify and understand name and related terms of various electronics components used in electronic circuits.: Identify different terminals of components, fid their values and observe numbering associate with it. 3. Use of oscilloscope and function generator: Use of oscilloscope to measure voltage, frequency/time and Lissajous figures of displayed waveforms. 4. Study of half wave and Full-wave (Bridge) rectifier with and without capacitor filter circuit. 5. Realization of basic logic gates: Truth table verification of OR, AND, NOT, NOT and NAND logic gates from TTL ICs 6. Regulated power supply: study LM78XX and LM79XX voltage regulator ICs 7. Transistor as a Switch: study and perform transistor as a switch through NOT gate 8. Zenner diode as voltage regulator 9. To study clipping and Clamping circuits 10. To study different biasing cirtis. 11. Study of CE amplifier and observe its frequency response.
Text Books, and/or reference material	Text Books: 1. Experiments Manual for use with Electronic Principles (Engineering Technologies & the Trades) by Albert Paul MalvinoDr., David J. Bates, et al. Reference Books: 1. The Art of Electronics 3e, by Paul Horowitz, Winfield Hill 2. Electronic Principles, by Albert Paul MalvinoDr. and David J. Bates

Mapping of CO (Course outcome) and PO (Programme Outcome)

Course	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
ECS51	CO1	3	2	1	2	2	1	-	-	2	-	-	-
	CO2	3	2	2	2	3	-	-	-	2	-	-	-
	CO3	3	3	2	2	-	-	-	-	2	-	-	-

Correlation levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Department of Electrical Engineering							
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	
EES51	ELECTRICAL TECHNOLOGY LABORATORY	PCR	0	0	2	2	1
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
None		CT+EA					
Course Outcomes	Upon successful completion of this course, the student should be able to •CO1: understand the principle of superposition.						

	•CO2: understand the principle of maximum power transfer •CO3: understand the characteristics of CFL, incandescent Lamp, carbon lamp. •CO4: understand the calibration of energy meter. •CO5: understand open circuit and short circuit test of single-phase transformer. •CO6: analyze RLC series and parallel circuits •CO7: understand three phase connections. •C08: understand determination of B-H curve
Topics Covered	**List of Experiments:** 1. To verify Superposition and Thevenin's Theorem. 2. To verify Norton and Maximum power transfer theorem 3. Characteristics of fluorescent and compact fluorescent lamp 4. Calibration on energy meter 5. To perform the open circuit and short circuit test on single phase transformer 6. To study the balanced three phase system for star and delta connected load 7. Characteristics of different types of Incandescent lamps 8. Study of Series and parallel R-L-C circuit 9. Determination of B-H Curve for magnetic material
Textbooks, and/or reference material	Textbooks: 1. Handbook of Laboratory Experiments in Electronics and Electrical Engineering by A M Zungeru, J M Chuma , H U Ezea 2. Laboratory Courses in Electrical Engineering (5^{th} Edition) by S. G. Tarnekar, P. K. Kharbanda, S. B. Bodhke, S. D. Naik, D. J. Dahigaonkar (S. Chand Publications)

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	1	1	1	2	2	2	3
CO2	3	3	3	3	3	1	1	1	2	2	2	3
CO3	3	3	3	3	3	1	1	1	2	2	2	3
CO4	3	3	3	3	3	1	1	1	2	2	2	3
CO5	3	3	3	3	3	1	1	1	2	2	2	3
CO6	3	3	3	3	3	1	1	1	2	2	2	3
CO7	3	3	3	3	3	1	1	1	2	2	2	3
CO8	3	3	3	3	3	1	1	1	2	2	2	3

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	
XXS-52	**Co-curricular Activities**	PCR	**0**	**0**	**2**	**2**	**1**

CURRICULUM AND SYLLABUS FOR INTEGRATED MSC IN CHEMISTRY

Pre-requisites	Course assessment methods: (Continuous evaluation((CE) and end assessment (EA)
NIL	CE + EA
Course Outcomes	• CO1: Social Interaction: Through the medium of sports • CO2: Ethics: Recognize different value systems including your own, understand the moral dimensions of your decisions, and accept responsibility for them • CO3: Self-directed and Life-long Learning: Acquire the ability to engage in independent and life-long learning in the broadest context socio-technological changes. • CO4: Personality development through community engagement • CO5: Exposure to social service
Topics Covered	**YOGA** • Sitting Posture/Asanas- Gomukhasana, Swastikasana, Siddhasana, Ustrasana, Janusirsasana, ArdhaMatsyendrasana (Half-Spinal Twist Pose), Paschimottanasana, Shashankasana, Bhadrasana. • Mudra- Vayu, Shunya, Prithvi, Varuna, Apana, Hridaya, Bhairav mudra. • Laying Posture/Asanas- Shalabhasana (Locust Posture), Dhanurasana (Bow Posture), ArdhaHalasana (Half Plough Pose), Sarvangasana (Shoulder Stand), Halasana (Plough Pose), Matsyasana, SuptaVajrasana, Chakrasana (Wheel Posture), Naukasana (Boat Posture), Shavasana (Relaxing Pose), Makaraasana. • Meditation- 'Om'meditation, Kundalini or Chakra Meditation, Mantrameditation. • Standing Posture/Asanas- ArdhaChakrsana (Half Wheel Posture), Trikonasana (Triangle Posture), ParshwaKonasana (Side Angle Posture), Padahastasana, Vrikshasana (Tree Pose), Garudasana (Eagle Pose). • Pranayama- Nadisodha, Shitali, Ujjayi, Bhastrika, Bhramari. • Bandha- Uddiyana Bandha, Mula Bandha, Jalandhara Bandha, Maha Bandha. • Kriya- Kapalabhati, Trataka, Nauli. **ATHLETICS** • Long Jump- Hitch kick, Paddling, Approach run, Take off, Velocity, Techniques, Flight & Landing • Discus throw, Javelin throw and Shot-put- Basic skill & Technique, Grip, Stance, Release & Follow through. • Field events marking. • General Rules of Track & Field Events. **BASKETBALL** • Shooting- Layup shot, Set shot, Hook shot, Jump shot. Free throw. • Rebounding- Defensive rebound, Offensive rebound. • Individual Defensive- Guarding the man without ball and with ball. • Pivoting. • Rules of Basketball. • Basketball game. **VOLLEYBALL** • Spike- Straight spike, Body turn spike, Tip spike, Back attack, Slide spike, Wipe out spike. • Block- Single block, Double block, Triple block, Group block.

	• Field Defense- Dig pass, Double pass, Roll pass. • Rules and their interpretation. **FOOTBALL** • Dribbling- Square pass, Parallel pass, Forward pass. • Heading (Standing & Running)- Fore head, Side fore head, Drop heading, Body covering during heading. • Kicking- Full volley, Half volley, Drop kick, Back volley, Side volley, Chiping (lobe). • Tackling: Covering the angle, Chessing time sliding chese, Heading time shoulder tackle etc. • Feinting- Body movement to misbalance the opponent and find space to go with ball. • Rules of Football. **CRICKET** • Batting straight drive. • Batting pull shot. • Batting hook shot. • Bowling good length, In swing. • Bowling out swing, Leg break, Goggle. • Fielding drill. • Catching (Long & Slip). • Wicket keeping technique. • Rules & Regulation. **BADMINTON** • Net play- Tumbling net shot, Net Kill, and Net Lift. • Smashing. • Defensive high clear/Lob. • Half court toss practice, Cross court toss drop practice, Full court Game practice. • Player Positioning, Placements. • Rules & Regulation. • Doubles & Mixed doubles match practice. **TABLE TENNIS** • Stroke: Backhand- Topspin against push ball, Topspin against deep ball, Topspin against rally ball, Topspin against topspin. • Stroke: Forehand- Topspin against push ball, Topspin against deep ball, Topspin against rally ball, Topspin against topspin. • Stroke- Backhand lob with rally, Backhand lob with sidespin, Forehand lob with rally, Forehand lob with sidespin. • Service: Backhand/Forehand- Push service, Deep push service, Rally service. • Service: Backhand sidespin (Left to right & Right to left). • Service: Forehand- High toss backspin service, High toss sidespin service, High toss reverse spin service. • Rules and their interpretations. • Table Tennis Match (Singles & Doubles).

	NCC • FD-6 Side pace, Pace Forward and to the Rear. • FD-7 Turning on the March and Wheeling. • FD-8 Saluting on the March. • FD-9 Marking time, Forward March and Halt in Quick Time. • FD-10 Changing step. • FD-11 Formation of Squad and Squad Drill. • FD-12 Parade practice. **TAEKWONDO** • Poomsae (Forms)- Jang, Yi Jang. • Self Defense Technique- Self defense from arms, Fist and Punch. • Sparring (Kyorugi)- One step sparring, Two step sparring, Fight (Free sparring). • Combination Technique- Combined kick and punch. • Board Breaking (Kyokpa)- Sheet breaking. • Interpretation Rules above Technique of Taekwondo. **NSS** • No Smoking Campaign • Anti- Terrorism Day Celebration • Any other observation/celebration proposed by Ministry/institute • Public Speaking • Discussion on Current Affairs • Viva voce

Mapping of CO (Course outcome) and PO (Programme Outcome)

Course	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
XXS52	CO1	-	-	-	-	-	2	-	-	3	-	-	-
	CO2	-	-	-	-	-	-	-	2	-	-	-	-
	CO3	-	-	-	-	-	-	1	-	-	-	-	3
	CO4	-	-	-	-	-	-	-	-	2	2	-	-
	CO5	-	-	-	-	-	3	1	-	-	-	-	-

Correlation levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

CURRICULUM AND SYLLABUS FOR INTEGRATED MSC IN CHEMISTRY

THIRD SEMESTER

<table>
<tr><td colspan="8">Department of Mathematics</td></tr>
<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>MAC331</td><td>MATHEMATICS-III</td><td>PCR</td><td>3</td><td>1</td><td>0</td><td>4</td><td>4</td></tr>
<tr><td colspan="2">Pre-requisites</td><td colspan="6">Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))</td></tr>
<tr><td colspan="2">Basic knowledge of topics included in MAC01 & MAC02.</td><td colspan="6">CT+MT+EA</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">• 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.</td></tr>
<tr><td>Topics Covered</td><td colspan="7">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]
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]
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</td></tr>
</table>

	only); Singular points and residues; Cauchy's residue theorem. [17] **Optimization:** **Mathematical Preliminaries:** Hyperplanes and Linear Varieties; Convex Sets, Polytopes and Polyhedra. [2] **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]
Text Books, and/or reference material	Suggested 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 Suggested 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 CO (Course Outcome) and PO (Programme Outcome):

POs	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1 0	PO1 1	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

Department of 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	
CYC301	**State of mater and chemical thermodynamics**	PCR	3	1	0	4	4
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment) (EA))					

CURRICULUM AND SYLLABUS FOR INTEGRATED MSC IN CHEMISTRY

NIL	CT+EA	
Course Outcomes	● CO1: Foundation in chemical thermodynamics. ● CO2: Understand the fundamental properties of different states of matter. ● CO3: Analyzing effect of various experimental parameters towards equilibrium condition of a chemical reaction/process. ● CO4: Numerical analysis on various thermodynamics properties.	
Topics Covered	**Kinetic Theory of Gases and Real gases** a. 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. 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 c. Deviation of gases from ideal behavior; 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; Existence of critical state, Critical constants in terms of van der Waals constants; Law of corresponding states d. Viscosity of gases and effect of temperature and pressure on coefficient of viscosity (qualitative treatment only) **Liquids** 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** 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	4L 6L 4L 2L 6L 6L

	Chemical Thermodynamics Second law and its elementary interpretation, Carnot's cycle and theorems, Refrigeration, Concept of entropy, Clausius inequality Gibbs and Helmholtz functions, Criteria of spontaneity, Thermodynamic probability, Thermodynamics equation of states; Thermodynamic relations; Thermodynamics of ideal mixing, Clausius-Clayperoneqn and phase diagram of single component systems, Joule-Thomson cooling effect. **Chemical Equilibrium** 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.	14L 4L
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)	

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

Department of 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	
CYC302	**Atomic structure and Chemical bonding**	PCR	3	1	0	4	4
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: know the history of development of the subject with the contribution of the scientist. ● CO2: to be exposed with quantization of energy, momentum and space. ● CO3: understand the behavior of electron in an atom in term of energy, momentum, position etc. ● CO4: knowledge about the hydrogen spectrum in absence and presence of magnetic field. ● CO5: know about Schrodinger equation and different quantum number. ● CO6: spin of electrons and spin quantum number ● CO7: orientation and shape of the atomic orbitals ● CO8: quantum mechanical treatment of VB and MOT ● CO9: understand the concept of hybridization of atomic orbital, the shape of the molecules, VB and MOT	
Topics Covered	Genesis: Planks quantisation of energy, photoelectric effect, Compton effect, De Broglie wave particle duality, Heisenberg uncertainty principle, wave function, Born interpretation	04
	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	04
	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	04 02
	Electron in magnetic field, Zeeman effect, spectrum of hydrogen atom and electron spin	02
	Many electron atoms and ions: Antisymmetric principle, Pauli's exclusion principle, Hund's rule, exchange energy, Aufbau principle	04
	Electronic energy level diagrams and electronic configurations of hydrogen-like and poly electronic atoms and ions, screening effect, Slater rule, approximate method, variation principle, spin orbit coupling, term symbol	01 02 05
	Covalent bond: Covalence bond: Lewis structure and octet rule, violation of octet rule Variation principle, one electron wave function, valence bond theory with H_2 Hybridisation, sigma bond, pi bond, delta bond, bond distance, bond energies, bond angle Directional property, shape, VSEPR	02

	Bond moment and dipole moments, hydrogen bond, inter molecular forces Molecular orbital theory, H_2^+, binuclear(AB) , tri nuclearAB_2 (linear and angular), Cyclic planar, Penta nuclearAB_4 (tetrahedral, square planer) , hepta nuclear AB_6 (octahedral) etc.	02 05
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 CO (Course Outcome) and PO (Programme Outcome)

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
CO7	3	2	3	3	--	1	--	2	1	2	2	1
CO8	3	2	3	3	--	1	1	2	1	2	2	1
CO9	3	2	3	3	--	1	1	2	1	1	2	1

Department of 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	
CYC 303	**Stereochemistry and Basic principle of organic chemistry**	PCR	3	1	0	4	4
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: 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 Nomenclature of bicyclic and Spiro compounds and reactivity based on stereochemistry ● CO5: To Learn Conformational analysis ● CO6: To Learn Chemistry of Functional Groups	
Topics Covered	1. Basic concept of stereochemistry : Isomerism; asymmetric and dissymmetric centres /molecules, Conformation and configurational nomenclature 2. Molecular symmetry: chirality, chiral axis, helicity, 3. Regio-, chemo- and stereoselective reactions 4. Nomenclature of spiro and bicyclic compounds, reactivit6y based on stereochemistry 5. conformational analysis of acyclic and cyclic compounds 6. Chemistry of functional groups: Preparation, properties, reactions, separation and identification of compounds containing various functional groups	25 lecs 15Lecs
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 : S. H. Pine	

Mapping of CO (Course Outcome) and PO (Programme Outcome)

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	1	1	2	3	3	1	3	2
CO5	3	3	3	3	2	3	3	3	3	3	3	3
CO6	3	3	3	3	3	3	3	3	3	3	3	3

CURRICULUM AND SYLLABUS FOR INTEGRATED MSC IN CHEMISTRY

<table>
<tr><td colspan="8">Department of Chemistry</td></tr>
<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>CYS351</td><td>Qualitative analysis of organic samples</td><td>PCR</td><td>0</td><td>0</td><td>3</td><td>3</td><td>1.5</td></tr>
<tr><td colspan="3">Pre-requisites</td><td colspan="5">Course Assessment methods: Continuous assessment and Viva-Voce at the end of the semester.</td></tr>
<tr><td colspan="3">None</td><td colspan="5"></td></tr>
<tr><td>Course Outcomes</td><td colspan="7">● 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.</td></tr>
<tr><td>Topics Covered</td><td colspan="7">1. Mixed Melting Point Determination:
Urea – Cinnamic acid mixture of various compositions (1:4, 1:1, 4:1)
2. 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.
3. 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.
4. 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.
5. Sublimation (Simple and vacuum): Camphor, Naphthalene, phthalic acid and Succinic acid.
6. 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.
7. Identification of unknown organic compound:
Identification of an organic compound through the functional group analysis, determination of melting point and preparation of suitable derivatives.</td></tr>
</table>

Text Books, and/or reference material	Suggested Text Books: (i) Textbook of Practical Organic Chemistry by Vogel (ii) A text-book of practical organic chemistry by Subhas C Das (iii) A text book on chemistry practical: Nad, Mahapatra and Ghosal

Mapping of CO (Course Outcome) and PO (Programme Outcome)

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

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 (CT), mid-term (MT) and end assessment (EA))					
NIL		CT+MT+EA					
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..						

CURRICULUM AND SYLLABUS FOR INTEGRATED MSC IN CHEMISTRY

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 CO (Course outcome) and PO (Programme Outcome)

Course	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
PHC334	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

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

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	
PHS384	**Physics II Laboratory**	PCR	**0**	**0**	**3**	**3**	**1.5**
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 CO (Course outcome) and PO (Programme Outcome)

Course	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
PHS382	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

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

CURRICULUM AND SYLLABUS FOR INTEGRATED MSC IN CHEMISTRY

FOURTH SEMESTER

<table>
<tr><td colspan="8">Department of Chemistry</td></tr>
<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="2">Pre-requisites</td><td colspan="6">Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))</td></tr>
<tr><td colspan="2">None</td><td colspan="6">CT+MT+EA</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">● CO1: Understanding the Chemistry behind biological processes
● CO2: Development of basic knowledge of cell structure and function
● CO3: Learning of different chemical aspects of biomolecules such as Carbohydrates, Lipids, Proteins, Nucleic acids
● CO4: Generation of concepts on molecular mechanics amongst biomolecules as a stepping-stone towards Biophysical Chemistry.</td></tr>
<tr><td>Topics Covered</td><td colspan="6">1. Amino Acids and Protein Chemistry:
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
2. Chemistry of mono, di, oligo and poly-saccharides
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.
3. Lipid chemistry
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
4. Structure and function of DNA and RNA, nucleosides, nucleotides,
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.</td><td>10

6

5

12</td></tr>
</table>

CURRICULUM AND SYLLABUS FOR INTEGRATED MSC IN CHEMISTRY

Text Books, and/or reference material	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).

Mapping of CO (Course Outcome) and PO (Programme Outcome)

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, chemical kinetics and catalysis**	PCR	3	1	0	4	4
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment) (EA)					
NIL		CT+EA					
Course Outcome	● CO1: Concept of phase rule and phase diagram of multi-component system. ● CO2: Understand the fundamentals of chemical kinetics and corresponding theoretical treatment. ● CO3: Concept of catalysts towards reaction rate and its applications. ● CO4: Numerical analysis of the effect of various parameters on reaction kinetics.						
Topics Covered	**Phase rule and phase diagram:** Phase rule equation (derivation excluded); phase diagram of water and sulphur system, Two component system, Miscibility (phenol-water) and distillation of completely miscible binary liquid mixtures; azeotropes, Steam distillation. 10L **Colligative properties:** Raoult's law of vapour pressure and colligative properties: osmosis, lowering of freezing point, elevation of boiling point, experimental methods of determination of molecular weights of substances in dilute solutions, van't Hoff 'i' factor and abnormal behaviour of electrolytic solutions. 10L						

	Chemical Kinetics: 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 by half-life and differential method. 8 L Temperature dependence of rate constant; Arrhenius equation, energy of activation Lindemann theory of unimolecular reaction. Collision theory; Transition State theory. Effect of ionic strength (primary and secondary salt effect), dielectric constant and pressure on rate. Kinetics of different composite reactions, including Auto-catalytic and Oscillating reactions. 10L **Catalysis:** Rate expressions for Homogeneous and heterogeneous catalytic reactions including acid-base catalyzed reaction, bimolecular surface catalyzed reaction, and enzyme catalyzed reactions. Determination of turnover number of an enzyme. 6 L
TextBooks,	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	1	3	2	1	1	3	2	1	1	2
CO2	3	1	1	3	2	1	1	3	2	1	1	2
CO3	3	1	1	3	2	1	1	3	2	1	1	2
CO4	3	1	1	3	2	1	1	2	2	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	
CYC403	**Chemistry of Elements and Radioactivity**	PCR	3	1	0	4	4
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA)					
NIL		CT+EA					

CURRICULUM AND SYLLABUS FOR INTEGRATED MSC IN CHEMISTRY

Course Outcome	● 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 lec **s block element:** general trends of elements and their compounds: Hydrides, oxides halides and other salts 2 lec **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 lec **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 lec **Radioactivity:** Discovery of Radioelement, Nature of radiations, Characteristics of Alpha, Beta, Gamma rays and positrons 2 lec Nuclear versus chemical reactions, Radioactive decay and recovery, Theory of radioactive disintegration, Cause of Radioactivity, Disintegration series and group displacement law. 3 lec Measurements of radioactivity, Rate of radioactive decay, Determination of decay constant and half-life, Determination of average life, Radioactive equilibrium, numerical problems 4 lec Artificial transmutation, cyclotron, Artificial radioactivity, Man-made element, Syntheses of Actinide elements 2 lec 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 lec 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 lec Nuclear Fission, Nuclear fusion, nuclear spallation, Nuclear binding energy and packing fraction, Nuclear binding forces, Nuclear shell model: Magic number 3 lec

CURRICULUM AND SYLLABUS FOR INTEGRATED MSC IN CHEMISTRY

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 CO (Course outcome) and PO (Programme Outcome)

	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

Department of 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	
CYC 404	**Organic Reaction Mechanism and Reactive Intermediates**	PCR	3	1	0	4	4
Pre-requisites		Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))					
None		CT+MT+EA					
Course Outcomes	● CO1: To Learn methods for investigating of organic reaction mechansims ● CO2: To Learn various aspect of Elimination treactions ● CO3: To Learn various aspects of addition reactions to C-C multiple bonds ● CO4: To Learn synthetically useful addition reactions to C-hetero multiple bonds ● CO5: To Learn the fundamentals of nucleophilic and electrophilic substitution reactions ● CO6: To learn basics of some molecular rearrangements and their application in synthesis ● CO7: To learn structure and reactivity of organic reactive intermediates						
Topics Covered	1. 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 isotope—isotope labelling, primary kinetic isotope effect, secondary kinetic isotope effect, cross over experiment 2 Lecs.						

	2. Elimination reactions: E1 , E2, and $E1_{CB}$ mechanism, effect of stereochemistry, regioselectivity, isotope and stereo electronic effects effect 4 Lecs 3. Addition to C-C 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, Sharpless asymmetric epoxidation. 3 Lecs. 4. Addition to Carbon- Hetero 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 enolates5 Lecs. 5. 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 sysyems 10 Lecs 6. 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 Lecs. 7. Chemistry of reactive intermediates: Formation, structure, stability , detection and reactions of carbocations, radicals, carbenes, nitrenes, carbions, arynes10 Lecs
Text Books, and/or reference material	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 CO (Course Outcome) and PO (Programme Outcome)

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

CO5	3	3	3	3	1	3	3	3	3	1	3	3
CO6	3	3	3	3	1	3	3	3	3	1	3	3
CO7	3	3	3	3	1	3	3	3	3	1	3	3

CYS451	**Thermodynamic Properties of Solution and Mixture Laboratory**	PCR (Practical)	**L** 0	**T** 0	**P** 4	**H** 4	**C** 2

Pre-requisites	Course Assessment methods (Continuous (CT) and end assessment) (EA)and Viva-Voce)
NIL	CT + Viva-voce

Course Outcome	● CO1: Characterization of thermodynamic parameters. ● CO2: Evaluation of fundamental properties of liquids. ● CO3: Interpreting molecular interaction. ● CO4: development of laboratory skill, data handling and interpretation, error analysis.
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 Any other practical as assigned by the Instructor
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	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**	PCR (Practical)	0	0	4	4	2
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
NIL		CT+ Viva voce					
Course Outcome (The students will master the following)		Course outcome accounts of ● 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 CO (Course outcome) and PO (Programme Outcome)

	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

CURRICULUM AND SYLLABUS FOR INTEGRATED MSC IN CHEMISTRY

CYS453	**Biochemistry Laboratory**	PCR (Practical)	**L** 0	**T** 0	**P** 3	**H** 3	**C** 1.5
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment) (EA)and Viva-Voce)					
NIL		CT + Viva-voce					
Course Outcome (The students will well-acquainted with)		● CO1: development of laboratory skill, data handling and interpretation, error analysis ● 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					
Reference material		1. Instruction manual provided by the Instructor 2. Vogel's Textbook of practical organic chemistry 3. An Advanced Curse in Practical Chemistry: Nad, Mahapatra and 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

CURRICULUM AND SYLLABUS FOR INTEGRATED MSC IN CHEMISTRY

FIFTH 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	
CYC501	**Fundamentals of Electrochemistry and surface chemistry**	PCR	3	1	0	4	4
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment) (EA))					
NIL		CT+EA					
Course Outcome (The students will master the following)		● CO1: Application of conductometric measurement. ● CO2: Understanding the dissociation of electrolytes in solution and its application.. ● CO3: Electro-chemcial cell: principle and application. ● CO4: Understanding the adsorption process. ● CO5: Fundamentals and application of micellar and colloid system.					
Topics Covered		**Conductance:** Electrolytic conduction, velocity of ions: specific, equivalent and molar conductances, Kohlrausch's law, strong and weak electrolytes, transport number, its determination, abnormal transport number, conductometric titrations, Applications of conductance measurement. 6L **Ionic equilibrium:** Concept of pH, pH of acids and bases, hydrolysis of salts, buffer solutions, pH metric titration, activity and solubility product: common ion and salt effect. 4L **Electrochemical cells:** Different types and evaluation of cell potential, various factors affecting the potential, determination of thermodynamic parameters, potentiometric titration, application of EMF measurement, Concentration cell, liquid junction potential, commercial cells including fuel cell, Li ion battery, dye sensitized solar cell. 12L **Adsorption:** Langmuir, BET, Gibbs adsorption isotherms, surface tension and surface pressure, contact angle: interfacial tension, Hysteresis. 6L					

	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. 8L **Colloidal system:** Theory of electrical double layer, zeta potential. Colloids: classification of colloidal systems, stability of colloids, their properties and applications. 6L
TextBooks,	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. Introduction to applied colloid and surface chemistry by G. M. Montogeorgis and S. Kill (Wiley) 6. 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	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	1	1	1	1	1	1	2	2	1	1	2
CO5	3	1	3	2	2	2	1	3	3	3	2	2

Department of 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	
CYC502	**Chemistry in Solution and Solid State Chemistry**	PCR	3	1	0	4	4
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: 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 aicds and bases(hydracids and oxyacids), levelling effect of water , solvent concepts, Bronsted Lowry concept, Lewis concepts	05
	Hard-Soft acid base concept, relation of hardness to ionisation potential and electronegativity and frontier orbital	02
	Thermodynamic of Lewis acid and base interaction, the Drago-Wayland equation	01
	Monoatomic ions and their acid –base properties, polyatomic ions and their acid-base properties	01
	Redox Chemistry:	
	Redox reaction, ion electron balancing, standard reduction potential and their diagrammatic representation	03
	Redox predominance diagrams of elements, disproportionation and metastable state	02
	Redox chemistry and extraction of elements from ores. Ellingham diagrams	02
	Effect of concentration and pH on redox reaction, uses of redox series in chemical reaction, Pourbaix diagrams	03
	Ionic equilibrium and precipitation reactions:	01
	Ionic compounds: Factors effecting ionic radii, Fajans rule, lattice energy, Born Haber cycle and its application	04
	Born Lande equation, modification of Born-Lande equation, Kapustinskii equation, radius ratio rule	04
	Solid State Chemistry:	
	Crystal system and lattices, unit cell, Miller planes, crystal packing, metallic bond	04
	ionic crystals, structures of AX, AX_2, AX_3, A_2X_3, type Structures of mixed metal oxides: spinel and inverse spinel, perovskite	04
	Crystal structure related to super conductivity, ferroelectric and piezo electric property, crystal defects, stoichiometric and nonstoichiometric defect, Schottkey and Frenkel defect, etc.	04
	Inorganic nanomaterial and polymers.	

CURRICULUM AND SYLLABUS FOR INTEGRATED MSC IN CHEMISTRY

Text Books, and/or reference material	Suggested Text Books: 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 CO (Course Outcome) and PO (Programme Outcome)

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

Department of 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	
CYC 503	**Chemistry of Heterocyclic Compounds and Natural Products**	PCR	3	1	0	4	4
Pre-requisites		Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))					
None		CT+MT+EA					

Course Outcomes	● CO1: Nomenclature, aromaticity acidity-basicity of heterocyclic compounds ● CO2: Synthesis and reactions of heterocyclic compounds ● CO3: Study of heterocycles with two or more hetero atoms including purine & pyrimidine ● CO4: Classification, general reactions of alkaloids aiding their isolation, purification and structure determination ● CO5: Structure determination, synthesis and reactions of simple alkaloids
Topics Covered	Nomenclature of heterocycles, common nomenclature, replacement method, Hantzsch-Widman (IUPAC or Systematic) method (3 Lec) Aromatic and nonaromatic heterocycles, molecular 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 Lec) Generalized approach to the synthesis of heterocycles possessing 5, 6 and 7 membered rings with one or two heteroatoms (3 Lec) Reactions of heterocycles: with particular emphasis on the mechanism of electrophilic substitution. Mechanism of nucleophilic substitution reactions in pyridine derivatives. Oxidation and reduction. (8 Lec) 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 Lec) Five and six membered heterocycles with two or more hetero atoms (4 Lec) Purine & pyrimidines: Structure, synthesis, reactions (4 Lec) Alkaloids: Classification; general reactions of alkaloids; chemistry of simple alkaloids like chavicine, piperine, nicotine, quinzoline ring. (14 Lec)
Text Books, and/or reference material	Suggested Text Books: 1. Organic Chemistry, Volume 2: Stereochemistry and the Chemistry Natural Products, I. L. Finar, Pearson Education India, 2002. 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 CO (Course Outcome) and PO (Programme Outcome)

CURRICULUM AND SYLLABUS FOR INTEGRATED MSC IN CHEMISTRY

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

<table>
<tr><td colspan="8">Department of Chemistry</td></tr>
<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>CYC504</td><td>Industrial Chemistry</td><td>PCR</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 (CT), mid-term (MT) and end assessment (EA))</td></tr>
<tr><td colspan="2">None</td><td colspan="6">CT+MT+EA</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">● CO1: Understanding the applications of chemistry in the industrial set-up
● CO2: Development of basic knowledge of industrial application
● CO3: Learning of different chemical tools which are useful and valued in industry
● CO4: Generation of knowledge to bridge the gap between education and industrial application so the students might be confident to apply for industrial career. .</td></tr>
<tr><td>Topics Covered</td><td colspan="6">1 Fuel: Coal, Petroleum, Gaseous fuels and Biofuels (including industrial process for liquefaction of coal, distillation of petroleum, analysis of coal)
2. Glass and ceramics: Different types of glass and ceramics, and their chemical compositions, reactions, chemical properties
3. Cement: Types, different types industrial preparations, composition and chemistry
4. Rubber and Plastic: Polymer Chemistry, introduction, types, structure, synthesis, natural rubber, vulcanization, thermosetiing plastics, industrial polymers and their chemistry
5. Paints and pigments: Introduction, definitions, types, emulsions, additives, anti-corrosion properties, chemical formulas and compositions
6. Biotechnology Industry: Introduction, Bioremediation of chemical waste, Bioleaching of ores, Biocatalyst, Fermentation, production of vinegar, Biofuel.</td><td>10

4

3

5

5

7</td></tr>
</table>

CURRICULUM AND SYLLABUS FOR INTEGRATED MSC IN CHEMISTRY

Text Books, and/or reference material	1. Industrial inorganic Chemistry by KH Büchel, HH 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

Mapping of CO (Course Outcome) and PO (Programme Outcome)

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

CYS551	**Chemical Kinetics, Surface Chemistry and Conductometry Laboratory**	PCR (Practical)	**L**	**T**	**P**	**H**	**C**
			0	0	3	3	1.5

Pre-requisites	Course Assessment methods (Continuous (CT) and end assessment) (EA)and Viva-Voce)
NIL	CT + Viva-voce

Course Outcome (The students will well-acquainted with)	● CO1: Monitoring kinetics of reactions by various experimental methods. ● CO2: Evaluation of adsorption isotherm. ● CO3: Knowledge of conductometric estimation. ● CO4: development of laboratory skill, data handling and interpretation, error analysis.
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 Any other practical as assigned by the Instructor

CURRICULUM AND SYLLABUS FOR INTEGRATED MSC IN CHEMISTRY

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	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

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 (CT) and end assessment (EA) along with Viva-Voce)					
NIL		CT and Viva voce					
Course Outcome (The students will master the following)		● 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 CO (Course Outcome) and PO (Programme Outcome)

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

Department of 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	0	0	3	3	1.5
Pre-requisites		Course Assessment methods: Continuous assessment and Viva-Voce at the end of the semester.					
None		CT+VIVA					
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 $-OCH_3$ group by Zeisel's method 2. Estimation of carbonyl group 3. Estimation of acetyl group 4. Estimation of amine group (van Slyke method) 5. Estimation of nitrogen by Kjeldahl method 6. Estimation of phosphorus 7. FAME analysis by GC/ GC-MS 8. Analysis of monosaccharide composition by HPLC 9. Quantitative estimation of C, H, N and S present in organic sample by CHNS analyzer.					

Text Books, and/or reference material	(i) Textbook of Practical Organic Chemistry by Vogel **(ii)** Comprehensive Practical Organic Chemistry: Quantitative Analysis by Ahluwalia

Mapping of CO (Course Outcome) and PO (Programme Outcome)

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	1
CO2	2	2	3	3	2	2	3	2	3	1	2	2
CO3	3	3	3	2	1	3	2	3	2	2	1	1

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, Spectroscopy, group theory and data analysis**	PCR	3	1	0	4	4
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment) (EA))					
NIL		CT+EA					

Course Outcome	● CO1: Physical understanding of photochemistry and photo-physical processes. ● CO2: Fundamentals of different molecular spectroscopy. ● CO3: Introduction to symmetry and concept of point group. ● CO4: Application of spectroscopy and symmetry to unravel the molecular structure. ● CO5: Concept of data analysis and its applications.
Topics Covered	**Photochemistry:** 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, Non-radiative processes,Concept of excited state life-time. Laws of photochemistry, quantum yield, kinetics of HI decomposition, H_2-Br_2 reactions, quenching, basic techniques of absorption and emission spectroscopy. 10L **Basics of spectroscopy:** Elementary idea of rotational, vibrational and electronic spectroscopy. 10L **Symmetry:** Introduction of symmetry and point groups, symmetry operations. Reducible and Irreducible representation and character table.10L **Data Analysis:** Statistical data analysis, mean, median, mode, frequency, standard deviations, mean deviation, etc. Frequency analysis, Normal distribution, Poisson distribution and others. Regression analysis, correlation. 12L
TextBooks,	1. Modern molecular photochemistry by N. J. Turro 2. Fundamentals of molecular spectroscopy by Banwell 3. Fundamentals of photochemistry by Rohatgi-Mukherjee 4. Statistical methods, vol 1 and 2 by N. G. Das 5. Group theory and chemistry by Bishop

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	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
CO4	3	3	2	2	1	3	1	3	3	3	3	2
CO5	3	1	1	3	1	1	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	
CYC602	**Coordination Chemistry**	PCR	3	1	0	4	4
Pre-requisites		Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))					
NIL		CT+MT+EA					
Course Outcome (Students will be enriched by)		● 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		Bloomstantrand-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 CO (Course outcome) and PO (Programme Outcome)

	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

Department of 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	
CYC603	**Reagents in Organic synthesis**	PCR	3	1	0	4	4
Pre-requisites		Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))					
None		CT+MT+EA					

Course Outcomes	● CO1: A basic idea on synthesis of organic compounds has been incorporated using some specific reagents for particular compound synthesis. ● CO2: How the better yield could be obtained, their strategy has been highlighted. ● CO3: Role of specific reagents and catalysts including mechanism in their transformation from substrate to products is included for their step by step synthesis.
Topics Covered	1. Some important reactions with reagents: Aromatic electrophylic (Friedel craft reaction) and nucleophilic substitution reactions, Cine substitution reactions, Aldol and Michael condensation reactions, Robinson annulation reaction; Synthesis of bio-molecules like steriod Oestrone-1, ± Zearalenone and Isonotkatone via Retro synthesis. 9L 2. Protection and deprotection of functional groups; Merrifield reagents (protection and deprotection of amino group in solid state peptide synthesis; Ring expansion and ring contraction reactions; Regio-selective and enantio-selective reactions controlled by special reagents, Assymmetric synthesis by Oxazoline derivatives, bis-lactone ether based chiral auxiliary. 9L 3. Special reagents and reactions: Barton reaction, Wittig reaction; Peterson's synthesis (olifination); 2,3-dichloro-5,6-dicyano-1,4 benzoquinone (DDQ); Umpolung reactivity (1,3-Dithianes); Dicyclohexyl-carbodiimide (DCC); OsO_4; Woodward and Prevost hydroxylation; SeO_2; Phase transfer catalyst, purple benzene, cryptates and clathro chelates; Wilkinson catalyst; hydroformylation reactions or Oxo reactions; Sapiro reaction; Favoriski reactions; Hoffmann-Löffler reaction; Baker's yeast (enzymatic reduction) and Gilman reagents. 9L 4. Special reagents used in oxidation and reduction organic transformation reactions: Oxidation reaction: CrO_3, pyridine complex, Mn(IV) oxide (used in retinal synthesis), RuO_4, Sharpless epoxidation, Moffat oxidation, Swern oxidation, Dess-Martin periodinane oxidation. Reduction reaction: hydride transfer reagents: DIBAL; Na(CN)BH; Trialkylborohydrides; trialkyltin hydride; Low valent titanium(II) oxide, diimide. 9L
Text Books, and/or reference material	**Suggested Text Books: (i) Modern Methods of Organic Synthesis 4th Edition, W. Carruthers Cambridge University Press** (ii) Reaction Mechanism in Organic Chemistry: S.M. Mukherji and S. P. Sinha; Macmillan India Pvt Ltd. (iii) Organic synthesis Through Disconnection Approach: P. S. Kalsi; (iv) Modern synthetic reactions by H. O. House. (v) Principles of Organic synthesis: R.O.C. Norman and J.M. Coxon; CRC Press

Mapping of CO (Course Outcome) and PO (Programme Outcome)

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

CURRICULUM AND SYLLABUS FOR INTEGRATED MSC IN CHEMISTRY

<table>
<tr><td colspan="8">Department of Humanities and Social Sciences</td></tr>
<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>HSC631</td><td>ECONOMICS AND MANAGEMENT ACCOUNTANCY</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 (CT), mid-term (MT) and end assessment (EA))</td></tr>
<tr><td colspan="3">NIL</td><td colspan="5">CT+MT+EA</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">● To review basic economic principles with students;
● To introduce students basic capital appraisal methods used for carrying out economic analysis of different alternatives of engineering projects or works;
● To educate the students on how to evaluate systematically the various cost elements of a typical manufactured product, an engineering project or service, with a view to determining the price offer.</td></tr>
<tr><td>Topics Covered</td><td colspan="7">PART 1: Economics
Group A: Microeconomics
Unit 1: Economics: Basic Concepts
Unit 2: Theory of Consumer Behaviour
Unit 3: Theory of Production, Cost and Firms
Unit 4: Analyses of Market Structures: Perfect Competition
Unit 5: Monopoly Market
Unit 6: General Equilibrium &Welfare Economics
Group B: Macroeconomics
Sl. No. Name
Unit 1: Introduction to Macroeconomic Theory
Unit 2: National Income Accounting
Unit 3: Determination of Equilibrium Level of Income
Unit 4: Money, Interest and Income
Unit 5: Inflation and Unemployment
Unit 6: Output, Price and Employment
PART 2: Accountancy
Sl. No. Name
Unit 1: Introduction to Accounting
Unit 2: Primary Books of Accounts (Journal)
Unit 3: Secondary Books of Accounts (Ledger)
Unit 4: Cash Book
Unit 5: Bank Reconciliation Statement
Unit 6: Trial Balance
Unit 7: Final Accounts</td></tr>
</table>

CURRICULUM AND SYLLABUS FOR INTEGRATED MSC IN CHEMISTRY

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. Anindya Sen: 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. Soumyen Sikder: 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 CO (Course Outcome) and PO (Programme Outcome)

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	
CYE611	**Analytical and Environmental Chemistry**	PEL	3	0	0	3	3
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA)					
NIL		CT+EA					
Course Outcome (Students will be enriched by)		● 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, poteiometric titration , ion selective electrodes etc. 18 **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. Radioactive and Biomedical waste disposal. Ecological balance and planning of Industrial complexes. Application of Bioreactors in industries for pollution control. Ecologically safe alternatives and basic principle of. Green chemistry. 18 lec
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 CO (Course outcome) and PO (Programme Outcome)

	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

CURRICULUM AND SYLLABUS FOR INTEGRATED MSC IN CHEMISTRY

<table>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Titleof 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>CYE612</td><td>Chromatographic Separation and Instrumental Methods of Analysis</td><td>PCR</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 (CT) and end assessment (EA)</td></tr>
<tr><td colspan="2">NIL</td><td colspan="6">CT+EA</td></tr>
<tr><td>Course Outcome (The students will master the following)</td><td colspan="7">• CO1: Get a comprehensive knowledge about solvent extraction, ion exchange and different chromatographic techniques
• CO2:Application of these techniques in practical and industrial capacity
• CO3:Working principles and application of some instrumental methods</td></tr>
<tr><td>Topics Covered</td><td colspan="7">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
Ion exchange, ion exchange resin, ion exchange equilibria, application of ion exchange methods, home water softeners
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)
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
High performance liquid chromatography: partition or liquid liquid chromatography, adsorption or solid liquid chromatography, ion exchange or ion chromatography, size exclusion chromatography, and chiral chromatography
Instrumental method:
Thermoanalytical Techniques: thermogravimetric analysis (TGA), Introduction, principle, instrumentation, Factors affecting TGA, application, differential thermal analysis, principle, instrumentation, application</td></tr>
</table>

	Electroanalyticaltechniques:electrogravimetry,electricalcomponents,Galvanostat and potentiostat, principle, experiments, coulometry, principle, colulometer, coulometry cell, constant current coulometry Polarography: Principal, process of current, polarogrphic cell, Ilkovic equation, half wave potential, experimental set up, application, quantitative and qualitative analysis, c y c l i c voltammetry: principal, cellconfiguration, instrumentation and circuit, application Atomic absorption spectroscopy: Principle, Instrumentation, application 02
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 CO (Course outcome) and PO (Programme Outcome)

	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

CYS651	**Potentiometric and Colorimetric Analysis**	PCR (Practical)	**L** 0	**T** 0	**P** 3	**H** 3	**C** 1.5
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment) (EA)and Viva-Voce)					
NIL		CT + Viva-voce					
Course Outcome (The students will well-acquainted with)		● 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 quin-hydrone 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 Fe3+/Fe2+ system 6. Determination of Solubility product of silver chloride potentiometrically Any other practical as assigned by the Instructor
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 (CT) and end assessment (EA) along with Viva-Voce)					
NIL		CT and Viva voce					
Course Outcome (The students will master the following)		● 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;					

CURRICULUM AND SYLLABUS FOR INTEGRATED MSC IN CHEMISTRY

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 CO (Course Outcome) and PO (Programme Outcome)

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

Department of 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 Synthesis of Organic Compounds**	PCR	0	0	4	4	2
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA) and Viva-Voce)					
None		CT AND Viva-Voce					
Course Outcomes		● CO1: To reach a targeted product through singlestep 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-Mass and other spectroscopic method will be adopted ● CO4: To Learn Understand the basic concept behind separation process for most common spectroscopic method like; UV-Vis, FT-IR, NMR, ESI-Mass and GC-Mass. ● 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. Synthesis of Osazone 2. Preparation of triphenyl methanol 3. Synthesis of *tans*-p-anisalacetophenane (aldol) 4. Oxidation of 4-chlorobenzyl alcohol to 4-chlorobenzoic acid 5. Nitration of bromobenzene (aromatic substitution) 6. Preparation of 2-chloro-2-methyl butane from 2-methyl-2-butanol (substitution) 7. Reaction of 1,3-cyclopentadiene with maleic anhydride (Diels-Alder reaction)					

Text Books, and/or reference material	1. Vogel's Textbook of practical organic chemistry 2. Advanced practical chemistry : Subas C. Das 3. An Advanced Curse in Practical Chemistry: Nad, Mahapatra and Ghoshal

Mapping of CO (Course Outcome) and PO (Programme Outcome)

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

CURRICULUM AND SYLLABUS FOR INTEGRATED MSC IN CHEMISTRY

SEVENTH SEMESTER

<table>
<tr><td colspan="8">Department of Management Studies</td></tr>
<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>MSC731</td><td>PRINCIPLES OF MANAGEMENT</td><td>PCR</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 (CT), mid-term (MT) and end assessment (EA))</td></tr>
<tr><td colspan="2"></td><td colspan="6">CT+MT+EA</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">• 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
• C05: To impart knowledge on each functional area of management like Marketing, Finance, Behavioral Science and Quantitative Techniques and decision science</td></tr>
<tr><td>Topics Covered</td><td colspan="7">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(8)
UNIT II: Quantitative tools and techniques used in management: Forecasting techniques, Decision analysis, PERT & CPM as controlling technique (7)
UNIT III: Creating and delivering superior customer value:Basic understanding of marketing, Consumer behavior-fundamentals, Segmentation, Targeting & Positioning, Product Life cycle. (8)
UNIT IV: Behavioral management of individual: Motivation, Leadership, Perception, Learning. (8)
UNIT V: Finance and Accounting: Basics of Financial management of an organization, Preparation of Final Accounts, Analysis of Financial statements, Cost Volume Profit (CVP) Analysis, An overview of financial market with special reference to India. (12)</td></tr>
<tr><td>Text Books, and/or reference material</td><td colspan="7"><u>Suggested Text Books</u>:
1. Financial Management, 11th Edition, I M Pandey, Vikas Publishing House.
2. Marketing Management 15th Edition, Philip Kotler and Kelvin Keller, Pearson India
3. Management Principles, Processes and practice, first edition, Anil Bhat and Arya Kumar, Oxford Higher education</td></tr>
</table>

	4. Organizational Behavior,13 th edition, Stephen P Robbins, Pearson Prentice hall India 5. Operations Management, 7th edition (Quality control, Forecasting), Buffa & Sarin, Willey Suggested Reference Books:

Mapping of CO (Course Outcome) and PO (Programme Outcome):

POs **COs**	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1									3	2	2	
CO2				2					2	2		
CO3				2					3	2		
CO4							1		3			
CO5				2					2	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	
CYC701	**Quantum Chemistry and Spectroscopy**	PCR	3	1	0	4	4
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment) (EA))					
NIL		CT+MT+EA					
Course Outcome (The students will master the following)		● CO1: Foundationinquantummechanicstoremindthedifferencebetweenmacroscopic (classical) and microscopic (quantum) world. ● CO2: Understandtheconceptofquantizationofenergyandwave-particleduality ● CO3: Solving Schrödinger wave equation for model quantum systems. ● CO4: Understand the bases behind interaction of light and matter and account for most common spectroscopic methods. ● CO5:Analyzingmicroscopicintramolecularinteractionsandpropertiesof molecules					

CURRICULUM AND SYLLABUS FOR INTEGRATED MSC IN CHEMISTRY

Topics Covered	Fundamentals of quantum mechanics: operators, functions, basic postulates 5 LecTime-independentSchrödingerequation,freeparticle,particleinaboxofvariousdimensions, 3 Lec Tunnelling effect 2Lec Rigid rotation in a plane 2Lec Rotation of diatomic molecule, spherical harmonic functions 3LecH armonicoscillator 2 Lec Electronicwavefunctionofhydrogenandhydrogen likeatom 3Lec Magneticeffecton electronmovement 2Lec Raisingand loweringoperators 2Lec Manyelectrontheory,Slaterdeterminant, Pauliexclusionprinciple 2Lec Time-dependentSchrödingerequation 2 Lec Atomicandmoleculartermsymbol 2 Lec Atomicspectra 2 Lec Pure rotational and vibrational spectra of diatomic and polyatomic molecules 3 L Vibrational-rotationalcoupling 2Lec Raman spectroscopyofmolecules,concept of molecularpolarizability 4Lec Electronicspectraofmolecules 2Lec
TextBooks, and/or reference material	1.Quantum ChemistrybyLevine 2.PhysicalChemistry:AMolecularapproachbyDonaldA.McQuarrie 3.IntroductoryquantumchemistrybyA. K.Chandra 4.Chemicalapplications ofGroup theorybyF. A. Cotton 5.MolecularQuantum MechanicsByAtkinsandFriedman,Oxford 6.Fundamentalsof molecularspectroscopyByBarnwell and McCash.

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

CURRICULUM AND SYLLABUS FOR INTEGRATED MSC IN CHEMISTRY

<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>CYC702</td><td>Inorganic reaction mechanisms and magnetochemistry</td><td>PCR</td><td>3</td><td>1</td><td>0</td><td>4</td><td>4</td></tr>
<tr><td colspan="2">Pre-requisites</td><td colspan="6">Course Assessment methods (Continuous (CT) and end assessment (EA))</td></tr>
<tr><td colspan="2">NIL</td><td colspan="6">CT+MT+EA</td></tr>
<tr><td>Course Outcome (The students will master the following)</td><td colspan="7">● 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.</td></tr>
<tr><td>Topics Covered</td><td colspan="7">(i) Stoichiometric mechanism, second order limiting rate constant, base hydrolysis, Effects of non-leaving ligands, proton exchange, activation parameters 5Lec
(ii) Stereochemistry of octahedral substitution reactions, racemisation reaction (Bailar twist and Ray –Dutt twist) 4Lec
(iii) 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. 4Lec
(iv) 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. 5Lec
(v) Inner sphere electron transfer process: steps, rate law, types of inner sphere electron transfer process, bridging ligand, remote attack, the chemical mechanism. 4Lec
vi) 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 3Lec
(vii) 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 2Lec</td></tr>
</table>

	(viii) Microstates and derivation of Russel-Saunders Terms for p^2, d^2 and pd configuration, Spin-orbit interaction 2Lec (ix) 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 3Lec (x) 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 3Lec (xi) Magnetic properties of Lanthanides, first transition series metal ions and actinides 2Lec (xii) Determination of magnetic susceptibility: Gouy's method, Faraday's method, NMR method and their advantage and disadvantages, magnetic anisotropy. 3Lec (xiii) 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. 2Lec (xiv) 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. 2Lec
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

Mapping of CO (Course outcome) and PO (Programme Outcome)

	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

Department of 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	
CYC703	**Concept of organic synthesis and asymmetric synthesis**	PCR	3	1	0	4	4

CURRICULUM AND SYLLABUS FOR INTEGRATED MSC IN CHEMISTRY

<table>
<tr><td colspan="2">Pre-requisites</td><td>Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))</td></tr>
<tr><td colspan="2">None</td><td>CT+MT+EA</td></tr>
<tr><td>Course Outcomes</td><td colspan="2">● CO1: A complete knowledge on tactics, strategy and control for the synthesis of organic compounds has been elaborately discussed using some specific reagents for particular compound synthesis.
● CO2: How the better yield of product could be obtained, their tactics, strategy and control has been highlighted.
● CO3: Role of specific reagents with related mechanism in their transformation and mechanistic path from substrate to products is included for their step by step reactions.</td></tr>
<tr><td>Topics Covered</td><td colspan="2">Planning Organic Syntheses:
1. Tactics, Strategy and Control; Slectivity: chemoselectivity, regioselectivity, streoselectivity: 2L
2. Making Carbon-carbon single and double bonds: Enolates, homoenolates, extenddenolates, nitrogen analogues of enols and enolates, acyl anion equivalents, allyl anions, specific enol equivalents, Michael reaction, σ-complexes of metals, orgnometallic reagents, aldol addition and condensation reactions, Mukaiyama aldol condnsation, control of facial reactivity, Claisen and Dieckmann condensation, conjugate addition, orthostrategy for aromatic compounds, reactions involving carbocation, carbenes and radicals, vinyl anion equivalent, allyl cation equivalent, Palladium catalysed coupling reactions.
Olefination reactions – wittig and related reactions, Julia olefination. Sulfenylation and selenenylation, hydroalumination, carboalumination, ROMP and RCMP. 8 L
3. Functional group interconversions and Retrosynthetic analysis: Synthones and synthetic equivalents, functional group interconversions and order of events in organic synthesis. One group - C-X and two groups C-X disconnections, chemoselectivity, reversal of polarity, cyclisation reactions, amine synthesis. One group C–C and two group C–C disconnections (typical examples), use of acetylenes and aliphatic nitro compounds in organic synthesis. Diels-Alder reactions, 1,3- and 1,5-difunctionalised compounds, α, β-unsaturated carbonyl compounds, control in carbonyl condensation, Michael addition and Robinson annealation. Ring synthesis: saturated heterocycles synthesis of 3-, 4-, 5-, and 6-membered rings, aromatic heterocycles in organic synthesis. 8L
4. Classic total synthesis of some natural products: Strategies and synthesis of some classic examples of total synthesis; Periplanone B, penicillin V, reserpine, erythronolide B, thienamycin, biotin, menthol, strychnine by Woodwards method. 10L
5. Asymmetric synthesis: Control of stereochemistry, chiral pool, asymmetric induction via reagents, asymmetric induction via substrate, asymmetric induction via catalysis, kinetic resolution, enantiomerically pure compounds and sophiscticated synthesis. 8L</td></tr>
</table>

CURRICULUM AND SYLLABUS FOR INTEGRATED MSC IN CHEMISTRY

Text Books, and/or reference material	Suggested Text and reference Books: ● Organic Chemistry by J. Clayden, N. Greeves, S. Warren & P. Wothers, Oxford University Press, 2001 ● Organic synthesis strategy and control by P. Wyatt & S. Warren, Wiley, 2007. ● Advanced Organic Chemistry by F.A. Carey & R.J. Sundberg, Springer, 2007. ● Principles of Organic Synthesis, R.O.C. Norman & J.M. Coxon, Nelson Thrones, 1993, CRC Press. ● Organic synthesis by M. Smith, Elevier, 4th Edition, 2016. ● 6. Classics in Total Synthesis: Targets, strategies and Methods by K.C. Nicolaou& E.J. Sorensen, Wiley, 1996. ● 7. Modern Methods in Organic Synthesis by W. Carruthers, Cambridge University Press, 2004. ● 8. Protective Groups in Organic Synthesis by T.W. Green & P.G.M. Wuts, Wiley, 2002.

Mapping of CO (Course Outcome) and PO (Programme Outcome)

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

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	
CYC704	**Mathematicaland computational chemistry**	PCR	3	0	0	3	3
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment(EA))					
NIL		CT+EA					

CURRICULUM AND SYLLABUS FOR INTEGRATED MSC IN CHEMISTRY

Course Outcome	● CO1:Foundationinbasicmathematicaltechniquesthatarecommonlyusedinchemistry. ● CO2:Learntheartofscientificprogrammingtosolvechemicalproblems. ● CO3:Writesimpleprogramsformatrixdiagonalisation,solvenumericaldifferentiation,integration and elementarydifferential equations. ● CO4:Applycomputationalmethodstocomplexproblemsofgrouptheory,quantumchemistry,molecularspectroscopy,chemicalkineticsandothertopics. ● CO5:Introductiontocomputationalchemistrysoftwarepackagesforquantum mechanicalandmacromolecularmodelling.
Topics Covered	Complexnumbersinchemistry:representationofcomplexnumber,Euler'sformula,rotational operators, periodicity, periodicity in circle, Periodicity in line, rotation inquantummechanics. 2 Lec Linearalgebrainquantummechanicsandsymmetryoperation:Vectorspace,determinants, matrix and liner transformations, orthogonal transformation,symmetryoperations,matrixeigenvalueproblemetc. 3LecDifferentialequationandchemistry:rateprocess,harmonicoscillator,waveequationfor harmonic oscillator,particle inbox, particle inaring 2LecTheLegendre equation,Legendrepolynomials,associatedLegendre polynomial,orthogonalityandnormalisation,Hermiteequation,Laguerreequation,associatedLaguerrefunctions,separableequationinchemicalkineties. 2 LecPartialdifferentialequation:generalsolution,separationofvariable,particleinarectangularbox,inacirclebox,hydrogenatom,vibratingstring,normalmodesofvibration. 3 Lec Function in three dimension: spherical polar coordinates, Density functions, atomicorbitals, volume integrals, average value, Maxwell velocity distribution, Laplacianoperatoretc. 3 Lec Fourier Transform in IR and NMR spectroscopy and X ray diffraction: orthogonalexpansions and Fourier analysis, Fourier series, periodicity, Fourier transforms,Fouriertransformpairsandapplicationin IR,NMRandX-raysdiffraction. 3 Lec Introduction to Fortran/Python language: data types, integer, complex, character,logicalconstantsandvariables.Arithmeticstatements,expressions,libraryfunction,relationaloperators. 2Lec Inputandoutputstatements,I/Oformatstatements,differenttypesofcontrolstatements. 1Lec Loop structures, subscribed variables and arrays. Writing and executing of simpleexampleprogrammes. 2 Lec Programmingexercisestochemicalproblems 5Lec --- ApplicationofDensityFunctionalTheoryusingGaussian(orsimilar)softwareinchemistry. 5 Lec Basicconceptonmacromoleculemodellingsoftware. 3Lec

Text Books, and/or Reference material	1. TheChemistryMathsBooks, ErichSteiner, Oxford 2. Mathematicsforchemistry, DoggettandSuiclific,Logman. 3. MathematicalforPhysicalchemistry: F.Daniels,Mc.GrawHill. 4. Chapman,Fortran95/2003forScientistsandEngineers,McGraw-HillInternationalEdition, New York (2006). 5. V.Rajaraman,ComputerProgramminginFortran90and95,PHILearningPvt.Ltd, New Delhi (1997). 6. W.H.Press,S.A.Teukolsky,W.H.Vetterling,B.P.Flannery,FortranNumericalRecipes (Fortran 90),CambridgeUniversityPress(1996) 7. UserReferenceManualforGaussian09software

MappingofCO(Course Outcome)andPO(ProgrammeOutcome)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	2	3	3	3	2	1	2	3
CO2	3	3	3	2	2	3	3	3	2	1	2	3
CO3	3	3	3	2	3	3	3	3	2	1	2	2
CO4	3	3	3	2	3	3	3	3	2	1	2	2
CO5	3	3	3	2	3	3	3	3	2	1	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	
CYS751	**Spectro photochemical Analysis**	PCR (Practical)	0	0	3	3	1.5
Pre-requisites		Course Assessment methods (Continuous(CT) and end assessment(EA) along with Viva-Voce)					
NIL		CT and Viva-voce					
Course Outcome	● CO1:Basicconceptsofspectrophotometric estimation						

(Thestudents will master thefollowing)	● CO2:Learningabouthandlingofspectrophotometerandfluorescencespectrometerand theirbasic theory. ● CO3:Todeveloplaboratoryskillsandtheabilitytoworkindependentlyaswellasin a group. ● CO4:Knowingpresentation,analysisandinterpretationofdata,sourceoferrorand error analysis. ● CO5: To understand the interconnection betweenexperimental foundationandunderlyingtheoretical principles. ● CO6:Todeveloptheabilityofscientificcommunicationsthroughoralquizzes, writtenreportsandpresentations.
Topics Covered	1. DeterminationofstoichiometryofFerricsalicylicacidcomplexbyJob ’s method 2. Determinationofindicatorconstantofmethylorange 3. DeterminationofconcentrationofCu^{2+}andFe^{3+}photometricallybytitratingwith EDTA 4. Determinationofarsenic(III)andantimony(IV)simultaneouslyina mixturespectrophotometrically. 5. Determinationofmolarextinctioncoefficient 6. Determinationoffluorescencequantumyield. 7. Fluorescencequenchingexperiment:determinationofmicellaraggregationnumber. Someadditional experimentsas decidedbythe Instructor.
Text Books, and/orReference material	1. Instruction manual provided by the Instructor 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									
CO2	3	3		2	2	3		2	2		1	
CO3						2		2	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	
CYS752	**Spectrophotometric Estimation of Cations and Anions**	PCR (Practical)	0	0	3	3	1.5
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA) along with Viva-Voce)					
NIL		CT and Viva voce					
Course Outcome (The students will master the following)		● 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, 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 $MnO4^{-}$ –$Cr_2O_7^{2-}$ mixture Estimation of Cu^{+2}–Zn^{+2} 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 CO (Course outcome) and PO (Programme Outcome)

	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

CURRICULUM AND SYLLABUS FOR INTEGRATED MSC IN CHEMISTRY

CYS753	**Separation and Identification of Organic Compounds from Binary Mixture**	PCR (Practical)	**L** 0	**T** 0	**P** 4	**H** 4	**C** 2
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment) (EA)and Viva-Voce)					
CYS351		CT + Viva-voce					

Course Outcome (The students will well-acquainted with)	CO1: Scientific knowledge on principle of separation techniques to reach a targeted pure separate component from a binary mixture, CO2: Become skilled to optimise the uses of solvent obeying the principle of green chemistry. CO3: Separation and purification techniques, like phase transfer, crystallization, GC-Mass and other spectroscopic method will be adopted CO4: Understand the basic concept behind separation process for most common different methodology and their principles like; distillation, sublimation, crystallization and solvent extraction will be adopted. CO5: To reach a maximum yield with minimum uses of solvent, reagents and energylike; 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-liquid) 5. Cyclohexanone/ cyclohexanol and N,N dimethyl aniline (liquid and liquid) In each case, separation and identification of individual components, preparation of derivatives of each component, their purification and characterization.
Referenc e material	1. *Vogel's* Textbook of practical *organic* chemistry, 5th Edition 2. Advanced *practical* chemistry, 3rd ed.: Subas C. Das 3. An Advanced Curse in Practical Chemistry, New Central Book Agency; 3rd ed.: Nad, Mahapatra and 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	2	2	2	1	3	2	2	1	2
CO2	3	3	2	2	2	2	2	3	2	2	1	2
CO3	3	2	3	2	2	2	2	2	2	2	1	2
CO4	3	2	3	2	3	3	1	3	2	3	1	2
CO5	3	3	2	2	3	3	2	3	2	3	1	2

EIGHTH 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	
CYC801	**Chemical, Statistical Thermodynamics and Electrochemistry**	PCR	3	1	0	4	4

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

Course Outcome

- CO1:understand the thermodynamics ofideal,non-ideal and multicomponentsystems.
- CO2: understand the concept ofentropy of a system at absolute zero and itsimplication.
- CO3: account for physical interpretation of partition functions and able to analysethermodynamic properties of model systems with using Boltzmann, Fermi-DiracandBose-Einstein statistics.
- CO4:understandtheionicpropertiesinsolution,likediffusion,migration,conductiona nd theirinterrelation.
- CO5: account for fundamental ideasofDebye-Huckeltheoryanditsapplication.

Topics Covered

Third law of thermodynamics:
Thirdlawofclassicalthermodynamicsandtheirapplications. 2L

Thermodynamics of non-ideal solution:
Thermodynamicsofidealandnonidealbinarysolutions:freeenergyand entropyofmixing,partialmolarquantitiesandtheirdetermination,fugacityandits determination, 4L
Gibbs-Duhemequation,Duhem-Margulesequation,equilibriumconstant, temperaturedependent equilibrium constant. 3L
Thermodynamicexcessfunctions.Experimentaldeterminationofactivity coefficientofelectrolytes andnonelectrolytes. 3L

StatisticalThermodynamics:
Introductiontostatisticalthermodynamics,probability,ensemblesanddistributionlaws. Partition function. 2L
ComparisonamongMaxwell-Boltzmann,Fermi-DiracandBose-EinsteinStatistics. 2L
Statisticalmechanicsonthethermodynamicsofmono,diatomicandpolyatomic ideal gas-contribution of rotation, vibration and translation topartitionfunction. Concept of residual entropy. 4L

	Electroniccontributiontothespecificheatofdiatomicgases. Solids- vibrational contribution to the specific heat of solids.Statisticaltreatment of Black-bodyradiation. Maxwell-Boltzmannprobabilitydistributionofmolecularvelocitiesandspeeds. Dynamicsofchemicalreactioninsolution-transitionstatetheoryusing partitionfunctions. 6L **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-PlanckFluxequation anditsapplication. 3L Transportofionthroughmembrane:Donanequilibrium. 2L
Text Books, and/or Reference material	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							

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	
CYC802	**Organometallic Compounds and Bioinorganic Chemistry**	PCR	3	1	0	4	4
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA)					
NIL		CT+EA					

Course Outcome (Students will be enriched by)	● 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 lec 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 lec Metal carbonyl: Binary carbonyl: synthesis, bonding, spectroscopic characterisation of carbonyl compounds, 4 lec Substituted carbonyl: phosphine, isocyanide, nitrosyl, dinitrogen, carbenes, hydrides, and dihydrogen, η1 alkyl, alkenyl, alkynyl, aryl, η2 alkene, alkyne, nonconjugateddiene, , butadiene, cyclobutadiene, cyclotetracene, allyllgand, cyclpopentadiene, and cycloheptatriene, Metallocenes: synthesis, reactivity and bonding of ferrocene etc. 6 lec 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 lec Cage and metal clusters. 3 lec 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 lec

	Biological ligands for metal ions: Nucleobases, nucleotides and nuclic 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 lec 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 lec 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 lec The dioxygen molecule, O_2 Uptake, transport and storage: Molecular and chemical properties of O_2, Oxygen transport and storage through Hemoglobin 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 spectroscopy4 lec 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 lec 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 lec
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 CO (Course outcome) and PO (Programme Outcome)

	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

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	
CYC803	**Pericyclic Reactions and Organic Photochemistry**	PCR	3	1	0	4	4
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA)					
NIL		CT+EA					
Course Outcome (The students will master the following)		● CO1: Understand the basic principles of pericyclic and organic photochemical reactions ● CO2: Understand the classification of different types of pericyclic and organic photochemical reactions ● CO3: Solving mechanism of pericyclic and organic photochemical reactions ● CO4: Understand the application of pericyclic and organic photochemical reactions					
Topics Covered		Pericyclic Reactions(18L): Molecular orbital symmetry, Frontier orbitals of ethylene, 1,3-butadiene, 1,3,5-hexatriene and allyl system. 3L Classification of pericyclic reactions. Woodward-Hoffmann correlation diagrams. FMO & PMO approach. 3L Electrocyclic reactions-conrotatory and disrotatory motions. 4n, 4n+2 system 4L Cycloaddition – antarafacial and suprafcial additions, 4n and 4n+2 systems, 2+2 addition of ketenes, 1,3 dipolar cycloadditions and cheletropic reactions. 4L 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. 4L Organic Photochemistry (20L): General information, Photo-chemical energy, effect of light intensity on the rate of photochemical reactions. Jablonski-diagram, photo-sensitisation and quenching. Norrish tyoe-I, type-II processes, Paterno-Buchi reaction, photochemistry of unsaturated compounds. 4L 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. 3L 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, dimerisation and oxetane formation. 4L					

	Aromatic compounds: Isomerisations, additions and substitutions. Miscellaneous photochemical reactions: Photo-Fries reactions of anilides, photo-fries rearrangement, Barton reaction, Singlet molecular oxygen reactions. 3L Photochemical formation of smog. 1L Photodegradation of polymers, photosubstitution, photoreduction of ketones, photooxidation, di-π methane rearrangement, photochemistry of arenes. 3L Organo-metalic photochemistry, photochemistry of vision. 2L
Text Books, and/or reference material	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 CO (Course outcome) and PO (Programme Outcome)

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

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	
CYE811	Advanced Natural Products and Medicinal Chemistry	PCR	3	0	0	3	3
Pre-requisites		Course Assessment methods (Continuous (CT)and end assessment (EA)					
NIL		CT+EA					
Course Outcome (The students will master the following)	• CO1:Understanding the importance of natural products • CO2: Learning of the structure, synthesis and uses of different Terpenes • CO3: Know the chemistry of Steroids in hormones • CO4: Develop knowledge of the chemical structure, synthesis of different natural pigments • CO5:Concept generation on rational medicinal chemistry and classification • CO6: Introduction to drug manufacturing done in pharmaceutical industries • CO7:Fundamental use of computer in drug design and discovery						
Topics Covered	Terpenes: Structural studies on sesqui terpenes, diterpenes, triterpenes and carotenoids; chemistry of carryophyllene, abietic acid, beta-amyrin, alpha and beta-carotenoids						9Lec

	Steroids and Prostanoids: Reaction and synthesis of steroids, sources of steroid hormones; diosgenin, hecogenin, etc., structure and synthesis of prostanoids Natural Pigments: General methods of isolation, structure elucidationandsynthesisofanthocyanins,flavones,flavones,isoflavones, aurone, chalcone, xanthone and their chemical interconversions Medicinal Chemistry: Definition, Concepts of LD50 and ED50, introduction to rational approach to drug design, physical and chemical factors associated with biological activities, structure-activity relationship, and mechanism of drug action. Classification of Medicine: Based on structure or pharmacological basis with examples. Antineoplastic agents, cardiovascular, local anti-infective, psychoactive, antibiotics (including vancomycin). Industrial synthesis of important medicines. Modelling: Molecular modeling, conformational analysis, qualitative and quantitative structure-activity relationship.	9Lec 9Lec 9Lec
TextBooks, and/or reference material	4. Asymmetric Synthesis of Natural products By Ari M PKoskinen (Wiley) 5. Chemistry of Natural products By S BBhat,B A Nagasampagi, M Sivakumar (Narosa) 6. Medicinal Chemistry: An introduction By Gareth Thomas (Wiley) 7. An Introduction to Medicinal Chemistry by GL Patrick (Oxford)' 8. Bioinformatics and Computational Biology in Drug Discovery and Development by William T. Loging (Cambridge)	

Mapping of CO (Course outcome) and PO (Programme Outcome)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	1	1	1	2	1	2	3	3	1	1
CO2	3	1	1	1	1	2	1	3	2	2	2	1
CO3	3	2	1	1	1	3	1	3	3	3	1	1
CO4	3	1	1	1	1	2	1	2	2	3	1	1
CO5	3	3	3	3	3	3	1	3	3	1	3	1
CO6	3	3	3	3	3	3	1	3	3	1	3	1
CO7	3	3	3	3	3	3	3	3	3	1	3	1

Department of 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	
CYE 812	**Spectroscopic methods of analysis**	PEL	3	0	0	3	3
Pre-requisites		Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))					
None		CT+EA					

CURRICULUM AND SYLLABUS FOR INTEGRATED MSC IN CHEMISTRY

Course Outcomes	· CO1: Understanding the principle and applications of UV-VIS, IR and Raman spectroscopy to elucidate the structure of different organic and inorganic molecules. · CO2: Understanding the principles of ESR spectroscopy and its application in the structure determination of inorganic complexes and reactive intermediates involved in organic and inorganic reactions. · CO3: Understanding the basic concept of Mössbauer Spectroscopy and usefulness of this technique to the studies of bonding and structures of inorganic compounds. · CO4: Understand the core concept of Mass Spectroscopic techniques and their contribution to the methods of structure elucidation of organic and inorganic species. ● CO5:Understand the different aspect of Nuclear Magnetic Resonance spectroscopy and its application in the field of structure determination of organic and inorganic species
Topics Covered	1. Applications of UV-VIS, IR and Raman spectroscopy to elucidate the structure of different organic and inorganic molecules. 4 Lecs 2. ESR spectroscopy: Hyperfine coupling, Spin polarization for atoms and transition metal ions, Spin-orbit coupling and significance of g-tensors, application to transition metal complexes including free radicals. 4 Lecs 3. Mössbauer Spectroscopy Basic principles, spectral parameters and spectrum display. Application of the technique to the studies of i) bonding and structures of FeII, FeIII compounds including those of intermediate- spin, ii) SnII and SnIV compounds, nature of M-L bond, coordination number and structure and iii) detection of oxidation states. 4 Lecs 4. Mass Spectroscopy Generation of ions and detection; EI, CI, FD, FAB, plasma desorption etc; fragmentation pattern in EI, GC-MS, MS-MS, LC-MS. Application of UV, IR, NMR and MS in structure elucidation. 8 Lecs 5. NMR Spectroscopy Long-range spin-spin interaction. Interpretation of non-first order NMR; double resonance, Lanthanide shift reagent, spin-tickling, INDOR, NOE, effect of solvents (aliphatic and aromatic), preliminary idea on 19F, 31P, 14N, 15N, 17O. NMR of solids, NMR imaging. 13C NMR Spectroscopy: Introduction, theory, instrumentation, chemical shift, coupling constants, application in organic molecules. 15 Lecs
Text Books, and/or reference material	1. Elements of magnetochemistry: Dutta and Shyamal 2. 2. Fundamental concept of Inorganic Chemistry (Vol-7): A. K. Das 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 7. Structural methods in Inorganic Chemistry : Ebsworth, Rankin and Cradock

CURRICULUM AND SYLLABUS FOR INTEGRATED MSC IN CHEMISTRY

Mapping of CO (Course outcome) and PO (Programme Outcome)

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	3	3	3	3	3	3	3
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
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

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	
CYS851	**Advanced Physical Chemistry Practical**	PCR			4	4	2
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment) (EA))					
CYS751		CT and viva-voce					
Course Outcome (The students will	● CO1: Basic concepts of spectrophotometric estimation and IR spectroscopy. Experimental knowledge on the influence of reaction parameters on the rate of there action, and analysis thereon. ● CO2:LearningabouthandlingofspectrophotometerandIRspectrometerand their basic theory.						
Topics Covered	1. DeterminationofisoelectricpHofgelatin. 2. Rateconstantofalkaline hydrolysisofcrystalviolet 3. Salteffectonthe rateof alkalinehydrolysisofcrystalviolet 4. Solventeffectonthe rateofalkalinehydrolysisofcrystalviolet 5. Micellareffectontherateofalkalinehydrolysisofcrystalviolet 6. IntermolecularhydrogenbondinginbenzylalcoholusingIRspectroscopy 7. Thermodynamicsofmicellization. 8. Determinationofactivationparameterofareaction. 9. Determinationofmean ionicactivitycoefficientofHClbyemfmeasurement.						
Text Books, and/or Reference material	1. Instruction manual provided by the Instructor 2. ExperimentsinPhysicalChemistrybyCarlGarland,JosephNibler,DavidShoemaker 3. Practicalsin PhysicalChemistrybyPS Sindhu 4. PracticalPhysicalChemistrybyViswanathan andRaghavan						

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	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

CYS852	**Synthesis and Characterisation of Complex Compounds**	PCR (Practical)	**L**	**T**	**P**	**H**	**C**
			0	0	3	3	1.5

Pre-requisites	Course Assessment methods (Continuous (CT) and end assessment (EA) and Viva-Voce)
NIL	CT + Viva voce

Course Outcome (The students will well-acquainted with)	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.
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

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	
CYS853	**Chromatographic Separation of Organic Compounds**	PCR	0	0	3	3	1.5
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA)					
NIL		CT+EA					
Course Outcome (The students will master the following)	● 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 CO (Course outcome) and PO (Programme Outcome)

	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

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

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 Quantum Chemistry and Application of Group Theory**	PCR	3	1	0	4	4
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment(EA))					
CYC701, 704		CT+EA					
Course Outcome	CO1: Different time dependent and time independent approximation methods tosolvevariousmolecularproblemswhenSchrödingerwaveequationcannotbesolvedexactly. CO2: Born-Oppenheimerapproximationtoseparatenuclearandelectroniccomponentsfrom molecular Hamiltonian. CO3:Detailedunderstandingontheinteractionofradiationwithmatterandselectionrulesfor transition amongdifferent molecularenergylevels. CO4:Hückeltheoryinconjugatedsystemanditapplications CO5: Development of concept of GOT, SALC from symmetry aspect and theirapplication CO6:Applicationsofgrouptheoryinspectroscopy,chemicalbonding						
Topics Covered	Variationandtimeindependentperturbationtheory(nondegenerateanddegenerate cases):Applicationtowardsdifferentsystems. 08 lec Antisymmetricandexclusionprinciple,Slaterdeterminalwavefunction,spin-orbitalinteraction:LS andJJ coupling,Termsymboland spectroscopicstates.04 lec Moleculesand chemicalbonding: Born-Oppenheimerapproximation:MOandVBtreatmentofdiatomicmolecules. 04 lecDirectedvalenceandhybridizationinsimplepolyatomicmolecules.Ideaofself-consistentfield. 04 lec Timedependentperturbationtheory:Transitiondipolemoment.Fermi'sGoldenrule.Einstein'scoefficientsforinducedandspontaneousemission. 04 lec						

	Hückeltheoryofconjugatedsystems.Bondorderandchargedensitycalculations.Applicationstoethylene, butadiene,cyclopropenylradical,cyclobutadiene.06lec Group theory: GOT, SALC: Their applications: representation of molecular orbitalsandshape 04 lec Application of Group theory in developing selection rules in spectroscopy02 lecApplicationincrystalfield theoryandmolecular orbitaltheory 02 lecConceptoforbital symmetryand applicationinchemical bonding 03lec Probabilityandefficiencyoftransitionsin IR and Ramanspectroscopy 03lec
Text Books, and/or Reference material	1. QuantumChemistrybyLevine 2.PhysicalChemistry: AMolecularapproachbyDonaldA.McQuarrie3.Introductoryquantum chemistrybyA. K.Chandra 4. Group theoryandchemistrybyBishop 5. Chemical applicationof group theorybyFA Cotton 6. Moleculartheoryandgrouptheorybyr.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	Title of the course	Program Core (PCR)/Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CYE912	**Non-Equilibrium Thermodynamics and Biophysical Chemistry**	PCR	3	1	0	4	4
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment) (EA))					
CYC401, CYC801		CT+EA					

Course Outcome	● CO1: difference between equilibrium and non-equilibrium thermodynamics andthe significance of the later. Understanding of different concepts and theories innon-equilibriumthermodynamics. ● CO2: Concept on stationary state, coupled transfer (like diffusion and electriccharge, heat and electric charge), entropy production and application of theseconcepts. ● CO3:Learningofdifferentbiophysicalprocessesinsideimportantbiomolecules ● CO4:DevelopknowledgeonvariousinstrumentaltechniquesusedinBiophysicalChemistry
Topics Covered	**Non-equilibriumthermodynamics:** 15Lec Postulates and methodologies, forces and fluxes, linear laws, Gibbsequation,Onsagarreciprocaltheory.Curie-Prigogineprinciple,diffusion, effusion, sedimentation, chemical affinities, membraneproperties.Thermoelectriceffects. Stationary states: time variation of entropy production, minimumentropyproduction, stabilityof stationarystate.Fluctuation. **Biophysical Chemistry:** Enzyme kinetics and Enzyme inhibition: Introduction of Enzyme,Enzyme-substrateKinetics,Enzymeinhibition,Reversibleinhibition,Irreversible inhibition, Competitive Inhibitor, Allosteric Inhibitor,Non-CompetitiveInhibitor,Biophysicalandkineticsstudiesofenzyme-inhibitorcomplex,Enzymesasdrugtargets,pharmacokinetics,pharmacodynamics,ADMETprofile,examplesofenzymetargeted drugdiscovery. Nucleic acid structure and therapeutics: Biophysical of nucleic acid,sensing and anti-sensing of nucleotides, interactions between strandsofnucleicacid, strand-displacement assayas sensor. 5Lec Techniquesformacromolecularseparation:Ionexchange,gelfiltrationchromatography,sedimentation,electrophoresisandisoelectricfocusing, Bio-analyticalChemistry: (i) Applications of X-ray, AFM, UV-Vis, CD, fluorescence, NMR incharacterizationofbiological macromolecules. 2 Lec (ii) Applications of the FRET and AUC to study conformationaldynamicsof protein andnucleoproteincomplexes. 3Lec (iii) ApplicationsofUV-VisandITCtostudythekineticsandthermodynamicsof protein-ligand binding. (iv) Application of different gel-based assays (SDS-PAGE, NativePAGE,denaturingPAGE,Agarose)todeterminenucleicacidstability and DNArepairprocess. 10Lec (v) Applicationofpull-downmethodandsequencing toanalyzeprotein-DNAinteraction.

TextBooks,and/orreference material	1. IntroductiontoThermodynamicsofIrreversibleProcessesbyI.Prigogine 2. Principlesof Physical biochemistrybyHolde, Johnson and Ho 3. Experimentalbiophysical ChemistryByCopeland, 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		2	2				3	2	1	1	
CO2	3		2	2				3	2	1	1	
CO3	3	3	3	2	2	3	2	3	2	2	2	1
CO4	3	3	3	2	3	2	2	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	
CYE913	**Material chemistry and advanced spectroscopy**	PCR	3	1	0	4	4
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment) (EA))					
CYC701,801		CT+EA					
Course Outcome(The students will master the following)		● CO1:Fundamentalsoflaserandapplicationinscience andindustry ● CO2: Properties and applications of semiconductors, superconductors,nanomaterials and manyotherindustriallyrelevant materials. ● CO3:Physicalchemistryofpolymer. ● CO4:sciencebehindmanymodernspectroscopicmethodsand applications					
Topics Covered		Laser: Fundamentals and applications, Time resolved laser spectroscopy(picosecond,femtosecondlaserspectroscopy)anditsapplication toinvestigatedifferentphotophysicalprocesseslikephoto-dissociation,photoisomerization(withareferencetovisionprocess)andrelatedtopics. 07 lec Freeelectrongastheoryofsolids: Fermi level,densityofstates. 04 lec Semiconductorandsuperconductor:propertiesand applications. 03 lec PhysicalChemistryofpolymers:Kineticsofpolymerization,thermodynamicsofmacromolecular systems. Determination of molar masses and studies ofconformationsandmorphologies,thermomechanicalpropertiesofpolymers.Sedimentationandultracentrifugationofmacromolecules. 07 lecFluorescencesensor,solarandfuelcell,supercriticalfluid,ionicliquids,Nanomaterials. 05 lec					

	Kineticsofdiffusioncontrolledreactions,photophysicalquenchingprocesses,excitedstatepHandacidityconstant,Charge-transferprocesses (Marcustheory). Experimentalmethodstoobserve kineticsoffastreactionsinsolution:stoppedflowandrelaxationmethods. 06 lec Advanced spectroscopy: NMR, X-ray photoelectron spectroscopy, Auger spectroscopy,Mossbouer spectroscopy,SEM 06 lec
Text Books, and/or Reference material	1. Modern spectroscopybyJMHollas 2. Solidstatechemistryandits applicationbyWest 3. ChemicalKinetics byK.J.Laidler 4. OrganicandphysicalChemistryofPolymersbyYGnanouandM.Fontaanille,Wiley 5. Atkin'sPhysicalChemistrybyPAtkinsandJ dePaula(7th ed.) 6. Fundamentalsof molecularspectroscopyByBanwelland McCash 7. FundamentalsofphotochemistryByRohatgi and Mukherjee.

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		1	1
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

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	**Electrode kinetics and corrosion science**	PCR	3	1	0	4	4

Pre-requisites	Course Assessment methods (Continuous (CT) and end assessment) (EA))
CYC801	CT+EA

Course Outcome (The students will master the following)	● CO1: process of adsorption and various adsorption isotherms involving different types of adsorbate-adsorbent combination. Application of adsorption isotherm to determine catalytic efficiency. ● 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:corrosionofvariousmetalsunderdifferentenvironmentalconditionsand mitigationmethods.

	Adsorption on solid: BET,Harkins-JuraandGibbsadsorptionisotherms,surfacetensionandsurfacepressure, contactangle:interfacialtension,Hysteresis. 4 lec **Micellesandmicroemulsions:**Phasediagramofmicellarsystem.Massactionmodeland pseudophasemodelfornon-ionicandionicmicelles.Relationshipbetweenthermodynamicpropertiesformicellizationwithcmc. 3 lecEstimationoffractionofcounterion,aggregationnumberandsolvationformicelles.Conceptofreversemicelleandmicroemulsion.Packingfactor. 4lecIon
	Electrical double layer: Electricaldoublelayer, Zetapotential,Stabilityofcolloids,Electrokineticeffect(electroosmosisandelectrophoresis) 3 lec **Electrode kinetics:** DerivationofButler-volmerequation,Studyofthekineticsofdifferentelectrodereactions(includingelucidation ofreaction mechanism).Numerical problems. 4 lec **Corrosion science:** Differentformsofcorrosion:propertiesandremedialmethods. 4 lec Tafelrelationandmixedpotentialtheory,Concept ofexchangeandlimitingcurrentdensity. 3 lec Potentio dynamic polarization and electrochemical impedance spectroscopic methods to determine rate of corrosion. 4 lecCorrosioncontrol:Cathodic(impressedcurrentmethodandmetalliccoating)andanodiccontrolmethods.Numericalproblems. 4 lecApplicationofcorrosioninhibitorsincludinggreeninhibitors 2 lec Hightemperaturecorrosion 3 lec
Text Books, and/or Reference material	1. ModernElectrochemistry2A-FundamentalsofElectrodicsbyBockrisandReddy 2. CorrosionEngineeringbyMG Fontana 3. CorrosionEngineeringbyBNPopov 4. SurfactantscienceandTechnology(3rded.) byD. Myers. 5. Principles of colloid and surface chemistry (3rded)by PC Hiemenz and R Rajgopalan

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

CYS951	Advanced Physical Chemistry-II Laboratory	PCR (Practical)	L 0	T 0	P 3	H 3	C 1.5
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment) (EA)and Viva-Voce)					
CYS751, 851		CT + Viva-voce					

Course Outcome (The students will well-acquainted with)	● CO1:basicunderstandingofvariousmodernelectrochemical,surfacecharacterization,spectroscopic techniques. ● CO2:knowledgeonmeasuringtherateofcorrosionofmetals anditsmitigationbychemical route. ● CO3:basicunderstandingonthedesignofsolarcell,nanomaterialpreparationandcharacterization. ● CO4:developmentoflaboratoryskill,datahandlingandinterpretation,error analysis.
Topics Covered	1. Determinationofrateofcorrosionofmetalusingpotentiodynamicpolarizationmethod 2. Determinationofrateofcorrosionofmetalusingelectrochemicalimpedancemethod 3. Evaluationofpotentialatzerochargeonametalsurfaceinpresenceofanelectrolyticsolution. 4. Determinationofcorrosioninhibitionefficiencyofanorganiccorrosioninhibitor. 5. Construction of a dye sensitized solar cell 6. Evaluationofexcitedstateprotontransferprocessin1-naptholbyexcitedstatelifetime measurement 7. Synthesisandcharacterizationofnanoparticles 8. Molecularmodellingprograms Any other practical as assigned by the Instructor
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	3	3	3		3		3	3			
CO2	3	3	3	3	3	3		3	3	2	2	1
CO3	3	3	3	3	3	3		3	3	2	3	1
CO4				3	3						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	
CYE921	**Advanced Green Chemistry and Analytical Chemistry**	PCR	3	1	0	4.0	4
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
NIL		CT+EA					
Course Outcome (The students will master the following)	● 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 Lecture 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 Lecture 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 Lecture 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. Air and water pollution laws and standards.						

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 CO (Course outcome) and PO (Programme Outcome)

	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**	PCR	3	1	0	4	4
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
CYC602 & CYC702		CT+EA					
Course Outcome (The students will master the following)	● 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 Lec
	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 Lec
	Phosphorus Based Ligands: Phosphine as Ligand, Monophosphines, Diphosphines, PolydentatePhosphines, Phosphate Ligands, Heterocyclic Phosphorus Ligands, Dialkyl- and Diarylphosphido Ligands	4 Lec
	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 Lec
	Sulphur Based Ligand: Thiolates, Disulphides, Thioethers, Sulphur Oxide, Dithiocarbamates, 1,2-Dithiolenes	3 Lec
	Metal-Organic Frameworks	2 Lec
	Supramolecular Chemistry:	
	Introduction, Host-Guest Chemistry, SelfAssembly, Supramolecular Building Blocks and Spacer, Driving Forces for the Formation of Supramolecular Structure	2 Lec
	Spatial Relationships between Host and Guest, Classification Of Host-Guest Compounds, General Introduction To Podand, Coronand, Spherand, Coronand-Podand Hybrid, Cryptands	2 Lec
	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 Lec
	Chiral Crown Ethers, Proton Ionisable Crown Ethers, Diester Crown Ethers, Synthesis of Lariat Ethers	2 Lec
	Synthesis of Calix[n] Arenes, Chiral Calix[n] Arenes, Introduction of Functional Groups in Calix[n] Arenes, Reactions at Upper Rim of Calixarene	3 Lec
	Selectivity of Cation Complexation, Cation Binding by Crown Ethers, Cation Binding by Lariat Ethers, Cation Binding by Cryptands, Thermodynamic Effect of Binding	4 Lec
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 CO (Course Outcome) and PO (Programme Outcome)

	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**	PCR	3	1	0	4	4
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
CY1102, 2014		CT+EA					
Course Outcome (The students will master the following)	Course outcome accounts of ● CO1: Diversified biological roles of Nitric Oxide (NO) and the NO donor drugs. ● CO2: Enemark-Feltham $\{MNO\}^n$ notation of metal nitrosyls and their spectroscopic and structural properties to elucidate structure-function relationship. ● CO3: 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. ● CO4: Details of structure function of Metalloenzymes responsible for N_2 fixation, reverse process of denitrification. ● CO5: Basics of nuclear chemistry, the nuclear spin (I), quadrupole moment (Q) and ellipticity of the nuclides and numerical problems. ● CO6: The concepts and working principle of three spectroscopy such as Nuclear Magnetic Resonance (NMR), Electron Paramagnetic Resonance (EPR) or Electron Spin Resonance (ESR) and Mössbauer spectroscopy (specifically the last two) those are related to nuclear spin and the s-electron density of the nuclides.					

Topics Covered	Importance of NO as ligand and its diverse roles in biology, NO Synthase enzyme and NO donors including metal nitrosyls, MO diagram of NO, Bonding nature of NO, Enemark-Feltham $\{MNO\}^n$ notation, Spectroscopic and structural properties of various $\{MNO\}^n$ species, NO detection methods, Electrophilic and nucleophilic reactivity on metal activated NO moiety 8 Lec Nitrite and Nitrous Oxide Reductase, their active site structures and catalytic activity and impact on Atmospheric Nitrogen Cycle 5Lec The N_2 fixation, Biological N_2 reduction using FeMo cofactor and Models, Chatt Cycle, Electrocatalytic reduction using low-valent tungsten (W), Mo(III) mediated N_2 reduction system, cleavage of N_2, Mo-N_2 complexes, N_2Redcution Mechanisms, Nitrogenase-related transformations 5Lec 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 nucleon and magnetic properties, Nordheim's rules, Nuclear magnetic resonance (NMR) 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 5 Lec Nuclear resonance or recoilless absorption and Mössbauer Spectroscopy; Recoiling Frequency shift, Frequency broadening and Doppler effect, Characteristics of Mössbauer nuclides and related Decay scheme, Quadrupole splitting, Isomer shift and its application to assign the spin states. 5Lec Electron spin resonance (ESR) spectroscopy: Interaction between electron spin and magnetic field, Techniques of ESR spectroscopy, Relaxation process and line widths in ESR transition, ESR relaxation and chemical bonding, Interaction between electron spin with nuclear spin: hyperfine/super hyperfine splitting, g values and factors affecting it, determination of g values, Zero field splitting, Kramer's degeneracy, applications of ESR measurement. 6 Lec Nuclear shell model, magic number and periodicity of nuclear properties, liquid drop model. 1 Lec Detection and measurement of radioactivity, Preparation of radio-isotopes, Cow and milk systems, Applications of radio-isotopes as tracers such as for chemical investigation, physico-chemical applications, age determination, medical applications, agricultural and industrial applications etc. 2Lec
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 and A. Syamal

Mapping of CO (Course outcome) and PO (Programme Outcome)

	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	Group theory, applied electrochemistry and X-ray structure analysis	PCR	3	1	0	4	4
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
NIL		CT+ EA					
Course Outcome	Course outcome accounts of · CO1: matrix representation of operator, formation of character tables of different point group and its application in analyzing vibration and electronic spectroscopy of complex molecules. · CO2: Use of character table, symmetry and projection operator to learn hybridization and formation of SALC and LCAO which enable to understand bonding in molecules. ·CO3: foundation in different electrochemical methods like cyclic voltammetry, coulommetry and associated techniques to analysis inorganic complexes and evaluating kinetic processes occurring at the electrodes-solution interface. · CO4: knowledge of unit cell, symmetry and space group of different crystal. · CO5: idea of reciprocal lattice and its importance in structure elucidation of inorganic complexes using X-ray diffraction technique. · CO6: understanding of the working principle of various electrochemical instruments as well as X-ray diffractometer.						

Topics Covered	**Group theory**: representation of groups, techniques and relationships for chemical applications, symmetry and chemical bonding, equation of wave functions, vibrational spectroscopy, transition metal complexes 12 lec **Electrochemistry**: fundamental of electrode reaction, basic equipment for electrochemical measurements, voltammetric techniques, coulometric techniques, electrochemical behaviour of transition metal complexes, metal complexes containing redox active ligands 12 lec **X-ray structure determination**: Diffraction of X-rays, Lattices, Plane and indices, X-ray diffraction. The reciprocal lattice, Brag's law in reciprocal lattice, crystal symmetry and space group, data collection, Intensity of data collection, theory of structure factors, and Fourier syntheses. 12 lec.
Text Books, and/or reference material	1. Electrochemical Methods: Fundamentals and Applications By Bard and Faulkner 2. Chemical applications of Group theory by F. A. Cotton 3. Molecular theory and group theory by R. L. Carter 4. Inorganic Electrochemistry: Theory, practice and application By P Zanello (RSC) 5. X-ray Crystallography By William Clegg (Oxford)

Mapping of CO (Course outcome) and PO (Programme Outcome)

	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
CO6	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	
CYS952	**Environmental Sample Analysis**	PCR (Practical)	0	0	3	3	1.5
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA) and Viva-Voce					
CY1152,2152		CT and Viva voce					

Course Outcome (The students will master the following)	● CO1:. The course is designed to give the students a broad understanding of the issues related to the basic concepts and principles of analysis of soil and water quality parameters. ● CO2: Students will also accumulate idea about the permissible limit, present concentration etc. of different environmental impurities. ● CO3:. Demonstrate an idea about the soil, water and wastewater quality standards and its regulations. ● CO4: Students will also accumulate idea about the soil quality status with respect to nutrients like N, P and K present.
Topics Covered	1. *p*H measurement of soil; 2. Estimation of organic carbon content in soil; 3. Chlorine content in drinking water; 4. Estimation of phenol in industrial waste-water sample 5. N, P and K of soil 6. Cyanide in industrial waste-water sample
Text Books, and/or reference material	1. 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. 2. Practical Environmental Analysis. Miroslav Radojevic & Vladimir N. Bashkin, Publisher: Royal Society of Chemistry; 2nd edition (April 26, 2006),ISBN-10: 0854046798, ISBN-13: 978-0854046799 3. Practical Manual of wastewater chemistry. Barbara A. Hauser,Publisher: CRC Press, 1st edition (June 1, 1996).ISBN-10: 1575040123 ISBN-13: 978-1575040127.

Mapping of CO (Course outcome) and PO (Programme Outcome)

	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	3	3	3	2	1	3	3	3	3	3
CO4	3	3	3	2	3	2	1	3	3	3	3	3

Department of 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	
CYE931	**Application of some important reactions in synthetic organic chemistry**	PCR	3	1	0	4	4
Pre-requisites		Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))					
None		CT+MT+EA					

Course Outcomes	● CO1: Understanding of mechanism of few important reactions, their application in different field of synthetic organic chemistry. ● CO2: Uses of strategy of Hydroboration and wittig reaction for carbon-carbon bond formation, reduction of methodology for specific transformation by Birch reduction, how the better yield of product could be obtained, their tactics, strategy and control has been highlighted. ● CO3: Role of specific reagents with related mechanism in their transformation and their mechanism from substrate to products is included for their step by step synthesis.
Topics Covered	1. Hydroboration reaction of alkenes, mechanism and hydrolysis process, Regioselectivity, stereoselectivity and Enantioselective hydroboration reaction, Uses of 9-BBN (in Suzuki Cross coupling reaction and others) and Monoisocamphenylborane ($IpcBH_2$), isomerisation of alkenes via hydroboration reactions, Carbon-Nitrogen, Carbon-halogen bond formation, synthesis of cyclopropyl, cyclobutyl derivatives and bicyclo compounds. 10 L 2. Birch Reduction: Mechanism, dependent factors, Application of birch reduction in aminolysis, hydrogenolysis, Wilds & Nelsen modification for pure products in Birch reduction, Regio-selectivity of Birch reduction. Hine postulates; Reduction of substitute benzenoid systems with EWG and EDG; biphenyl systems, regio-selective reduction of naphthalene and substituted naphthalene; Stereo selective of Birch reduction in naphthalene. Reduction of Anthracene and Phenanthrene systems; single electron transfer system (SET), application in natural product synthesis with special emphasis on Gibberalic acid. 10L 3. Wittig reactions or chemistry of Ylide: synthesis of phosphoylide; Stereo-chemical outcome of wittig reactions and their dependent factors. Stereo-selectivity in case of stabilised and non stabilizedylides. Scholar modifications. Effect of ligands in phosphorous ylide. Advantages of Wittig-Horner reaction over Wittig reaction; Difference in reactivity of phosphorous and sulphur ylide; Regio selective and stereoselective reaction with stabilized and non-stabalizes sulphur ylides. 10L
Text Books, and/or reference material	Suggested Text and reference Books: 1. F.A. Carey & R.J. Sundberg, Advanced Organic Chemistry, Springer, 2007 2. K.C. Nicolaou& E.J. Sorensen, Classics in Total Synthesis: Targets, strategies and Methods, Wiley, 1996. 3. W. Carruthers, Modern Methods in Organic Synthesis, Cambridge University Press, 2004. 4. Principles of Organic Synthesis, R.O.C. Norman & J.M. Coxon, Nelson Thrones, 1993, CRC Press. 5. Organic synthesis by M. Smith, Elevier, 4th Edition, 2016. 6. Recent published papers in reputed journals on Hydroboration reaction, Wittig reaction and Birch reduction have to follow as advance study for this elective paper.

Mapping of CO (Course Outcome) and PO (Programme Outcome)

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

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	Natural Products and Drug Design	PCR	3	1	0	4	4

Pre-requisites	Course Assessment methods (Continuous (CT) and end assessment (EA))
CYC401	CT+EA

Course Outcome (The students will master the following)	● CO1: Understanding the importance of natural products ● CO2: Learning of the structure, synthesis and uses of different Terpenes ● CO3: Know the chemistry of Steroids in hormones ● CO4: Develop knowledge on the chemical structure, synthesis of different natural pigments ● CO5: Concept generation on rational drug design and drug classification ● CO6: Introduction to drug manufacturing done in pharmaceutical industries ● CO7: Fundamental use of computer in drug design and discovery
Topics Covered	Terpenes: Structural studies on sesquiterpenes, diterpenes, triterpenes and carotenoids; chemistry of carryophyllene, abietic acid, beta-amyrin, alpha and beta-carotenoids — 9 Lec Steroids and Prostanoids: Reaction and synthesis of steroids, sources of steroid hormones; diosgenin, hecogenin, etc., structure and synthesis of prostanoids — 9 Lec Natural Pigments: General methods of isolation, structure elucidation and synthesis of anthocyanins, flavones, flavones, isoflavones, aurone, chalcone, xanthone and their chemical interconversions — 9 Lec Drug Design: Drug definition, Concepts of LD50 and ED50, introduction to rational approach to drug design, physical and chemical factors associated with biological activities, structure-activity relationship, and mechanism of drug action. — 9 Lec Classification of drugs: Based on structure or pharmacological basis with examples. Antineoplastic agents, cardiovascular drugs, local anti-infective drugs, psychoactive drugs, antibiotics (including vancomycin). Industrial synthesis of important drugs. Modelling: Molecular modeling, conformational analysis, qualitative and quantitative structure-activity relationship.

Text Books, and/or reference material	1. Medicinal Chemistry: An introduction By Gareth Thomas (Wiley) 2. Asymmetric Synthesis of Natural products By Ari M P Koskinen (Wiley) 3. Chemistry of Natural products By S B Bhat, B A Nagasampagi, M Sivakumar (Narosa) 4. An Introduction to Medicinal Chemistry by G L Patrick (Oxford)' 5. Bioinformatics and Computational Biology in Drug Discovery and Development by William T. Loging (Cambridge)

Mapping of CO (Course outcome) and PO (Programme Outcome)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	1	1	1	2	1	2	3	3	1	1
CO2	3	1	1	1	1	2	1	3	2	2	2	1
CO3	3	2	1	1	1	3	1	3	3	3	1	1
CO4	3	1	1	1	1	2	1	2	2	3	1	1
CO5	3	3	3	3	3	3	1	3	3	1	3	1
CO6	3	3	3	3	3	3	1	3	3	1	3	1
CO7	3	3	3	3	3	3	3	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	PCR	3	1	0	4	4
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
CYC401, CYC503		CT+EA					
Course Outcome (The students will master the following)	● CO1: Generation of concept on the interdisciplinary interface lies within Chemistry and Biology ● CO2: Learn the Chemistry of Nucleic acids (DNA, RNA) ● CO3: Develop knowledge on the enzyme chemistry ● CO4: Introduction of enzyme inhibitors and inhibition kinetics						

Topics Covered	Nucleoside, nucleotides and Nucleic acids: Basic concept and importance; Bio-synthesis of purine and pyrimidine nucleotides, synthesis of adenosine, Guanosine; Nucleotides: synthesis of adenyltlic acid(AMP), Guanylic acid(GMP), uridylic(UMP) acid and cytidilic acid; Cell structure, DNA structure and genetic material, replication and transcription of DNA, RNA and protein synthesis, genetic material and genetic code Enzyme Chemistry: Enzymes: Chemical and biological catalysts. Nomenclature and classification, concept and identification of active sites by use of inhibitors, catalytic power, specificity and regulation. Examples of some typical enzyme mechanisms for chymotripsin, and carboxypeptidase-A. Different types of enzyme catalyzed reactions, Co-enzyme chemistry. Enzyme models: Host-guest chemistry, chiral recognition, molecular asymmetry and prochirality, biomimetic chemistry, crown ether, cryptates, cyclodextrins, calixarin Bioorganic Chemistry: Enzyme kinetics: MichaelisMenten and Lineweaver-Burk plots, reversible and irreversible inhibition. Mechanism of enzyme action: Typical enzyme mechanism for ribonuclease, lysozyme. Chemical models and mimics for enzymes, receptors, peptides, carbohydrates and other bioactive molecules, catalytic antibodies- Design, synthesis and evaluation of enzyme inhibitors. Enzyme catalyzed reactions: Carboxylation and decarboxylation. Isomerization and rearrangement.	8 Lec 12 Lec 12 Lec
Text Books, and/or reference material	1. Principles of Biochemistry by Lehninger 2. Biochemistry by Voet&Voet 3. An Introduction to Medicinal Chemistry by G L Patrick (Oxford)	

Mapping of CO (Course outcome) and PO (Programme Outcome)

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

<table>
<tr><td colspan="8">Department of Chemistry</td></tr>
<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>CYE934</td><td>Advanced Stereochemistry and structure activity Correlation</td><td>PCR</td><td>3</td><td>1</td><td>0</td><td>4</td><td>4</td></tr>
<tr><td colspan="2">Pre-requisites</td><td colspan="6">Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))</td></tr>
<tr><td colspan="2">CYC303</td><td colspan="6">CT+EA</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">● 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 guide lines 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.</td></tr>
<tr><td>Topics Covered</td><td colspan="7">1. Advanced stereochemistry: Configarational analysis: Relative and absolute configuration. 2 Lec.
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. 8Lec.
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 Lec.</td></tr>
</table>

	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). 8Lec. 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 Lec.
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 CO (Course Outcome) and PO (Programme Outcome)

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

Department of 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	
CYS953	**Multi Step Synthesis and characterization of Organic Compounds**	PCR	0	0	3	3	1.5
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA) and Viva-Voce)					
CYS653		CT AND Viva-Voce					

Course Outcomes	● CO1: To reach a targeted product through multiple 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-Mass and other spectroscopic method will be adopted ● CO4: To Learn Understand the basic concept behind separation process for most common spectroscopic method like; UV-Vis, FT-IR, NMR, ESI-Mass and GC-Mass. ● 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. Oxidation of Benzoin to benzil followed by rearrangement to benzilic acid 2. Preparation ofbenzophenoneoxime followed by rearrangement tobenzanilide 3. Preparation of1,3,5tribromobenzenefrom 2,4,6- tribromoaniline via diazotization 4. Preparation ofdiethyl adipatefrom Cyclohexanol followed by Dickmann cyclisation to 2-carboethoxy cyclopentanone 5. Preparation of *p*-nitro aniline from acetanilide
Text Books, and/or reference material	1. Vogel's Textbook of practical organic chemistry 2. Advanced practical chemistry : Subas C. Das 3. An Advanced Curse in Practical Chemistry: Nad, Mahapatra and Ghoshal