AMRITA VISHWA VIDYAPEETHAM PROPOSAL FOR NEW ACADEMIC PROGRAM

1. Title of the Program:

4-years B.Sc. (Honors) with Research in Chemistry with Minor in Chemical Computing/Industrial Pharmaceutics/Forensic Data Science.

2. Need & Objective of the Program:

The proposed course is aligned with the National Education Policy (NEP) 2020. NEP emphasizes the holistic growth of the students from a multidisciplinary perspective. The present B.Sc. (Honors with Research) course in Chemistry aims to implement the ideas of NEP. The curriculum is designed in a way to provide a broad multidisciplinary knowledge from the very advent of the course to enable students to choose their area of interest.

The minors associated with this program are aimed at allowing the students to pursue their interests and acquire professional skills in the relevant fields. The present course is curated to enlighten students with specific industrial skills and requirements. Moreover, through this course, students will get the opportunity to learn first-hand from eminent industrial delegates via various minor and major projects. The main objective of this program is to familiarize the students with various research areas and encourage them to pursue a successful career in either academia or industry.

3. Potential for the Out-going Students:

On completion of the course, students will acquire the following insights:

- ★ Concrete knowledge on fundamental concepts in chemistry
- ★ Complete awareness on the technological advances in the field of chemistry
- ★ In-depth understanding of various real-life problems concerning chemistry
- ★ Proficiency to apply their gained knowledge in solving day-to-day problems facing society
- ★ Dedication to work towards a more sustainable future generation
- ★ Ability to adapt to changes and work in an inter-disciplinary environment for a common cause.
- ★ Adequate knowledge in ancillary subjects widening the scope to evolve in disciplines that require broader understanding of a problem.

4. Level of the Program : UG

5. School(s) under which the Program is to be offered:

School of Physical Sciences, Amrita Vishwa Vidyapeetham

6. Eligibility for Admission:

- Senior Secondary School Leaving Certificate or Higher Secondary (12th Grade and Chemistry, physics and mathematics) Certificate obtained after successful completion of Grade 12 or equivalent for 4-year B.Sc. (Honours) course.

Selection: Based on +2 marks, Entrance Test & Interview

7. **Duration of the Program:** 4 years (8 semesters)
8. **Pattern (Semester / Annual):** Semester, NEP
9. **Content of the Program (Core / Electives / Optional / Specializations)**

A. Program Outcome (POs):

A student completing the 4-year B.Sc. (Honors) with Research is expected to acquire the following skills:

i. **Critical thinking:** Be prepared for a successful career in industry as well as in academia implementing the research experience acquired from the program.

ii. **Problem-solving skills**: Develop problem solving skills in familiar and non-familiar contexts and apply one's learning to real-life situations

iii. **Creative thinking:** Provide imaginative, innovative, and lateral thinking to solve complex interdisciplinary problems with "out of the box" approach.

iv. **Communication Skills:** Ability to read, write, evaluate, and convey research papers and ideas critically and analytically.

v. **Value inculcation:** Embrace and practice humanitarian, constitutional, moral, and ethical values in everyday life, including universal human values and global citizenship values.

vi. **Environmental awareness and action:** Implement necessary measures to mitigate the atrocities of environmental degradation, climate change, and pollution towards a sustainable development of the society.

vii. **Skills to apply digital and technological solutions:** Acquire and deploy appropriate information and communication tools to excel in their higher education and future career.

B. Program Specific Outcome (PSOs):

A student completing the 4-year B.Sc. (Honors) with Research in Chemistry is expected to acquire the following skills:

i. Analyzing and critical thinking ability in broader interdisciplinary topics.

ii. Practice research-oriented knowledge for solving problems related to mathematics, physics, computer programming, energy materials, and drug designing.

iii. Acquiring practical, professional, and procedural skills in line with industrial internships and placements

iv. Programming skills and computational thinking towards scientific problems

v. Utilization of knowledge acquired from various fields of chemistry for solving real world problems.

vi. Inculcating awareness towards real-life environmental issues and development of sustainable methods to address them.

vii. Awareness and understanding towards alternate energy materials.

viii. Ability to identify, design and conduct appropriate experiments, interpret data obtained, draw pertinent conclusions and communicate all these effectively.

CREDITS AT A GLANCE

Sl No.	Category of Course	Number of Credits (Proposed)			Minimum Number of Credits (Prescribed by UGC)	
		3 year UG	4 year UG (Without Research)	4 year UG (With Research)	3 year UG	4 year UG
1	Major/Core Course (DSC)	77	108	93	60	80
2	Electives	6 (UG)	12 (UG)	12 (UG)		
3	Minor Courses*	18*	18*	18*	12-24	16-32
4	Multidisciplinary Courses (IDC)	17	17	17	9	9
5	Skill Enhancement Courses (SEC)	8	8	8	9	9
6	Ability Enhancement Courses (AEC)	10	12	12	8	8
7	Value Added Course (VAC) [Common for all UG programs]	12	14	14	6-8	6-8
8	Extension Activity (EA) / Online Courses	2	2	2	--	--
9	Open Elective (OE)	3	3	3	--	--
10	Summer Internship (minimum 1 month)	4	4	4	4	4
11	Dissertation	3		15		12
	TOTAL	142+18*	180+18*	180+18*	120	160

***Students pursuing 4-year B.Sc. (Honours) in Chemistry course have the option to acquire a Minor degree in Computational** Science/Industrial Pharmaceutics/Forensic Data Science by earning an additional 18 Credits from the list below.

10. Curriculum (Theory / Practical / Project work / Institutional Training / Hands-on Training)

For a detailed Syllabus & Curriculum Please See ANNEXURE –I

ANNEXURE -I

Course Code	Course Title	L T P	Cr	ES		CourseCode	Course Title	L T P	Cr	ES
SEMESTER 1						**SEMESTER 2**				
25MAT104 IDC	Single variable calculus and Matrix Algebra	3 0 0	3			25MAT111 IDC	Differential Equations and Transforms	3 0 0	3	
25PHY102 IDC	Mechanics & Optics	3 0 0	3			25PHY112 IDC	Electricity and Magnetism	3 0 0	3	
25CHY103 CORE COURSE	General Chemistry	3 1 0	4			25CHY113 CORE COURSE	Principles of Inorganic Chemistry	3 1 0	4	
25CSA104 (IDC)	Introduction to Scientific Computing using Python	3 0 0	3			25CHY114 CORE COURSE	Principles of Physical Chemistry	3 1 0	4	
AEC	Modern Indian Language (MIL)	2 0 0	2			25PHY182 IDC	Physics Lab – II	0 0 2	1	
22AVP103 (VAC)	Mastery Over Mind	1 0 2	2			25CHY181 CORE LAB	Chemistry Lab - I	0 0 3	1	
25PHY181 IDC	Physics Lab – I	0 0 2	1			24ENG101 (AEC)	English - I	2 0 0	2	
24ENV200 (VAC)	Environmental Science and Sustainability	3 1 0	4			22ADM111 (VAC)	Glimpses of Glorious India	2 0 1	2	
22ADM101 (VAC)	Foundations of Indian Heritage	2 0 1	2			25CHY100 (SEC)	Health and Wellness	1 1 0	2	
		Total	**24**				**TOTAL**		**22**	
SEMESTER 3						**SEMESTER 4**				
25CHY203 CORE COURSE	Principles of Organic Chemistry	3 1 0	4			25CHY213 CORE COURSE	Chemistry of Main Group elements	3 1 0	4	
25CHY204 CORE COURSE	Equilibria, Dilute solutions, Surface, and Photochemistry	3 1 0	4			25CHY214 CORE COURSE	Organic Synthesis – II	3 1 0	4	
25CHY205 CORE COURSE	Organic Synthesis – I	3 1 0	4			25CHY215 CORE COURSE	Quantum Chemistry	2 1 0	3	
25CHY281 CORE LAB	Chemistry Lab-II	0 0 3	1			25CHY282 CORE LAB	Inorganic Chemistry Lab	0 0 6	2	
25CHY271(Open Elective)	Chemistry in Daily Life	3 0 0	3			25CHY283 CORE LAB	Organic Chemistry Lab	0 0 6	2	
25CSA281(SEC)	Programming Lab I	0 0 2	1			(VAC)	Amrita Value Program II	1 0 0	1	
(VAC)	Amrita Value Program I	1 0 0	1			25CHY200 (SEC)	Scientific Writing and Technical Skills	2 1 0	3	
25CSA202 (SEC)	Digital and Technological Solutions	1 0 2	2			25LIV290[@]	Open Elective/Live in Lab@	2 0 0	2	
24ENG111 (AEC)	English - II	1 0 2	2							
	TOTAL		**22**				**TOTAL**		**21**	
SEMESTER 5						**SEMESTER 6**				
25CHY303 CORE COURSE	Coordination Chemistry	3 1 0	4			25CHY313 CORE COURSE	Organometallic Chemistry	3 1 0	4	
25CHY304 CORE COURSE	Electrochemistry	3 1 0	4			25CHY314 CORE COURSE	Bioorganic and Natural Products Chemistry	3 1 0	4	
25CHY305 CORE COURSE	Molecular Symmetry and Group Theory	2 1 0	3			25CHY315 CORE COURSE	Molecular Spectroscopy	3 1 0	4	
25CHY306 CORE COURSE	Analytical Chemistry	3 1 0	4			25CHY316 CORE COURSE	Statistical and Irreversible Thermodynamics	3 1 0	3	
25CHY383 CORE COURSE	Physical Chemistry Lab	0 0 6	2			23LSK211 (AEC)	Life Skills II	1 0 2	2	
CORE COURSE	Elective UG-I	3 0 0	3			CORE COURSE	Elective UG-II	3 0 0	3	
23LSK201 (AEC)	Life Skills I	1 0 2	2			25CHY385 CORE COURSE	Advanced Organic Chemistry Lab	0 0 6	2	
25CHY384 CORE COURSE	Advanced Inorganic Chemistry Lab	0 0 6	2				**TOTAL**		**22**	
	TOTAL		**24**			25CHY399	Minor Project (Exit option)	0 0 6	3	**25**
							TOTAL (for BSc. Exit-option)	**138**		

Exit with B.Sc. Degree in Chemistry [with a compulsory internship of one month, Credit: 4]
Total Credit earned: 138 + 4 [Internship]

SEMESTER 7	**SEMESTER 8**

25CHY401 CORE COURSE	Solid State Chemistry	3 0 0	3			25CHY411 CORE COURSE	Advanced Synthetic Organic Chemistry	3 1 0	4	
25CHY402 CORE COURSE	Physical Methods in Chemistry	3 0 1	4			25CHY412 CORE COURSE	Industrial Inorganic Chemistry	3 1 0	4	
25CHY403 CORE COURSE	Bioinorganic Chemistry	3 0 0	3			25CHY413 CORE COURSE	Industrial Electrochemistry	3 1 0	4	
25CHY404 CORE COURSE	Frontiers in Organic Chemistry	3 1 0	4			25CHY498 CORE COURSE	Minor Project	0 0 6	3	
CORE COURSE	**Elective UG-III**	3 0 0	3				**Total**		**15**	
CORE COURSE	**Elective UG-IV**	3 0 0	3				**OR**			
25CHY481 CORE COURSE	Advanced Physical Chemistry Lab	0 0 6	2			25CHY499	**Dissertation (BSc Honors with Research)**		**15**	
25RM500 (VAC)	Research Methodology	2 0 0	2							
23LSK301 (AEC)	Life Skills III	1 0 2	2							
	TOTAL		**26**							

Exit with (B.Sc. (Honors) without research / PG Diploma) Total Credit earned: 176+ 4 [Internship]
[with a compulsory internship of one month, Credit: 4]
Exit with B.Sc. (Honours) With Research– Total Credits Earned: 176 + 4 [Internship]

***Optional Minor Courses:**

1. Minor in Chemical Computing
2. Minor in Forensic Data Science
3. Minor in Industrial Pharmaceutics

Course Code	Course Title	L T P	Cr	ES		CourseCode	Course Title	L T P	Cr	ES
SEMESTER 3						**SEMESTER 4**				
25CHY231	Scientific Computing using Python + Lab (For Minor in Chemical Computing)	3 1 1	4			25CHY241	Machine Learning and AI + Lab (For Minor in Chemical Computing)	3 1 1	4	
25CHY232	Introduction to Forensic Science and Crime Scene Investigation (For Minor in Forensic Data Science)	3 1 0	4			25CHY242	Forensic Document Examination and Digital Forensics (For Minor in Forensic Data Science)	3 1 0	4	
25CHY233	Introduction to Pharmaceutical Chemistry (For Minor in Industrial Pharmaceutics)	3 1 0	4			25CHY243	Essentials of Drug Design (For Minor in Industrial Pharmaceutics)	3 1 0	4	
		Total	**4**					**Total**	**4**	
SEMESTER 5						**SEMESTER 6**				
25CHY341	Molecules and Materials Modelling (Theory + Lab) (For Minor in Chemical Computing)	**3 1 1**	**4**			25CHY351	Applied Computations (Theory) (For Minor in Chemical Computing)	3 1 0	**4**	
25CHY342	Forensic Chemistry and Toxicology (For Minor in Forensic Data Science)	**3 1 0**	**4**			25CHY386	Applied Computations (Lab) ((For Minor in Chemical Computing))	0 0 6	**2**	
25CHY343	Pharmacotherapeutic Compounds (For Minor in Industrial Pharmaceutics)	**3 1 0**	**4**			25CHY353	Forensic Biology and DNA Analysis (For Minor in Forensic Data Science)	3 1 0	**4**	
						25CHY387	Forensic Science & Documentation (Lab) (For Minor in Forensic Data Science)	0 0 6	**2**	
						25CHY355	Drug Development and Marketing (For Minor in Industrial Pharmaceutics)	3 1 0	**4**	
						25CHY388	Medicinal Chemistry (Lab) (For Minor in Industrial Pharmaceutics)	0 0 6	**2**	
		Total	**4**					**Total**	**6**	

Grand Total = 18 [Students have to take one minor paper (theory) every semester and one Lab paper in Semester 6 in streamlined fashion to acquire the Minor degree in a specifc area.]

ELECTIVES											
	Electives UG						**Electives PG**				
25CHY371	Batteries and Fuel Cells	3 0 0	3	E		25CHY631	Applied Electrochemistry	3 0 0	3	E	
25CHY372	Corrosion Science	3 0 0	3	E		25CHY632	Bioanalytical Chemistry	3 0 0	3	E	
25CHY373	Green Chemistry	3 0 0	3	E		25CHY633	Chemistry of Biomolecules	3 0 0	3	E	
25CHY374	Industrial Catalysis	3 0 0	3	E		25CHY634	Industrial Chemistry	3 0 0	3	E	
25CHY375	Introduction to Food Chemistry	3 0 0	3	E		25CHY635	Industrial Stoichiometry	3 0 0	3	E	
25CHY376	Polymer Chemistry	3 0 0	3	E		25CHY636	Material Science and Nanochemistry	3 0 0	3	E	
25CHY377	Surface Science and Coating Technology	3 0 0	3	E		25CHY637	Medicinal Chemistry	3 0 0	3	E	
25CHY378	Forensic Science	3 0 0	3	E		25CHY638	Supramolecular Chemistry	3 0 0	3	E	
AMRITA VALUE PROGRAMMES FOR UG PROGRAMMES						25CHY639	Nanomaterials for Biomedical Applications	3 0 0	3	E	
22ADM201	Strategic Lessons from Mahabharata	1-0-0	1			25CHY640	Industrial Metal Finishing Processes	3 0 0	3	E	
22ADM211	Leadership from Ramayana	1-0-0	1			25CHY641	Biosensors: Fundamentals and Applications	3 0 0	3	E	
22AVP210	Kerala Mural Art and Painting	1-0-0	1			25CHY642	Computational Chemistry	3 0 0	3	E	
22AVP201	Amma's Life and Message to the modern world	1-0-0	1			25CHY643	Sustainable Chemical Science	3 0 0	3	E	
22AVP204	Lessons from the Upanishads	1-0-0	1			25CHY644	Sustainable techniques in Chemical Sciences	3 0 0	3	E	
22AVP205	Message of the Bhagavad Gita	1-0-0	1			25CHY645	Introduction to Nanocomposites	3 1 0	4	E	
22AVP206	Life and Message of Swami Vivekananda	1-0-0	1			25CHY646	Electro and Photocatalytic Material	3 1 0	4	E	
22AVP207	Life and Teachings of Spiritual Masters of India	1-0-0	1			25CHY647	Silicon Chemistry and Drug Design	4 0 0	4	E	
22AVP208	Insights into Indian Arts and Literature	1-0-0	1			25CHY648	Polymer Science	3 1 0	4	E	
22AVP213	Traditional Fine Arts of India	1-0-0	1			25CHY649	Polymer Technology	3 1 0	4	E	
22AVP214	Principles of Worship in India	1-0-0	1			25CHY650	Introduction to photochemistry	4 0 0	4	E	
22AVP215	Temple Mural Arts in Kerala	1-0-0	1			25CHY651	Frontiers to photochemistry	4 0 0	4	E	
22AVP218	Insights into Indian Classical Music	1-0-0	1			25CHY652	Colour Chemistry	4 0 0	4	E	
22AVP219	Insights into Traditional Indian Painting	1-0-0	1			25CHY653	Chemistry of Natural Products	4 0 0	4	E	
22AVP220	Insights into Indian Classical Dance	1-0-0	1			25CHY654	Introduction to Nanotechnology	4 0 0	4	E	
22AVP221	Indian Martial Arts and Self Defence	1-0-0	1			25CHY655	Retrosynthetic Analysis	4 0 0	4	E	
22AVP209	Yoga and Meditation	1-0-0	1								
MODERN INDIAN LANGUAGES (MIL)											
24MAL101	Malayalam I	2 0 0	2			24MAL111	Malayalam II	2 0 0	2		
24HIN101	Hindi I	2 0 0	2			24HIN111	Hindi II	2 0 0	2		
24KAN101	Kannada I	2 0 0	2			24KAN111	Kannada II	2 0 0	2		
24SAN101	Sankrit I	2 0 0	2			24SAN111	Sanskrit II	2 0 0	2		
24TAM101	Tamil I	2 0 0	2			24TAM111	Tamil II	2 0 0	2		
OPEN ELECTIVE (OEL)											
24OEL631	Advanced Statistical Analysis For Research	2 0 0	2			24OEL646	Media Management	2 0 0	2		
24OEL632	Basics of PC Software	2 0 0	2			24OEL647	Object-Oriented Programming	2 0 0	2		
24OEL633	Computer Hardware And Networking	1 0 1	2			24OEL648	Painting And Sculpture	2 0 0	2		
24OEL634	Consumer Protection Act	2 0 0	2			24OEL649	Personal Finance	2 0 0	2		
24OEL635	Corporate Communication	2 0 0	2			24OEL650	Principles Of Advertising	2 0 0	2		
24OEL636	Design Studies	2 0 0	2			24OEL651	Principles of Packaging	2 0 0	2		
24OEL637	Disaster Management	2 0 0	2			24OEL652	Scripting for Rural Broadcasting	1 0 1	2		
24OEL638	Essentials Of Cultural Studies	2 0 0	2			24OEL653	Social Media Website Awareness	1 0 1	2		
24OEL639	Foundations Of Mathematics	2 0 0	2			24OEL654	Theatre Studies	1 0 1	2		
24OEL640	Foundations Of Quantum Mechanics	2 0 0	2			24OEL655	Writing for Technical Purposes	2 0 0	2		
24OEL643	Knowledge Management	2 0 0	2			24OEL656	Yoga and Personal Development	1 0 1	2		
24OEL644	Marketing Research	2 0 0	2			24OEL657	Fundamentals of Legal Awareness	2 0 0	2		
24OEL645	Media For Social Change	2 0 0	2			24OEL659	Glimpses of Life through Literature	2 0 0	2		
						24OEL660	Information Technology in Banking	2 0 0	2		

SEMESTER 1

25MAT104 Single Variable Calculus and Matrix Algebra 3 0 0 3

Course Outcomes:

CO1: Understand the elementary functions and concepts of limit, continuity, derivative, and integral

CO2: Analyze various techniques of differentiation and integration.

CO3: Applications of differentiation and integration.

CO4: Evaluate linear independence and rank and solve for a system of linear equations.

CO5: Analyze the notion of eigenvalues and eigenvectors, eigen basis and the possibility of diagonalization.

Unit 1

Review – Functions, shifting, and scaling. Limits, one-sided limits, and limits at infinity, Continuity, types of discontinuities.

Unit 2

Derivatives, differentiation techniques, implicit differentiation. Applications of Derivative – Extreme values of functions, Concavity, and Curve Sketching.

Unit 3

Integration - Definite Integrals, Properties of definite integrals. Integration techniques – integration by parts and integration by substitution. Fundamental theorem of Calculus. Applications of Integrals - Volumes by slicing and rotation about an axis.

Unit 4

Review – Matrices, operations on matrices, determinants. Linear systems, Gauss elimination, linear independence, rank of a matrix.

Unit 5

Eigenvalues and eigenvectors, Symmetric, Skew Symmetric and Orthogonal matrices, Eigen bases, Diagonalization.

TEXTBOOKS:

1. Calculus, G. B. Thomas, Pearson, 2009, Eleventh Edition.

2. Advanced Engineering Mathematics, Erwin Kreyszig, Wiley India, Tenth Edition, 2015.

REFERENCE BOOKS;

1. George Turrell, Mathematics for Chemistry and Physics, Academic Press, 2002.

2. Herbert S. Wilf, Applied Mathematics for Physical Chemistry, 2nd Edition, Prentice Hall, 1998.

25PHY102 Mechanics & Optics 3 0 0 3

Course Outcomes:

CO1: Identifying various motions in 1D, 2D, and 3D utilizing the fundamental principles of vectors and laws of motions.
CO2: To investigate the concept of work and energy to clarify the energy conservation in collisions.
CO3: To examine various forms of oscillation and relate the concept to that of waves.
CO4: To analyse various aspects of geometrical optics and the interference phenomena and to learn its various manifestations
CO5: Investigate the applications of optics in field of optical fibers and holography.

Unit 1 Motion

Motion in 1D; vectors, motion in 2D & 3D, projectile and uniform circular motion; relative motion and relative velocity.
Force, mass, Newton's laws, inertial mass, examples of forces, free body diagram analysis for simple applications; friction and contact forces, drag force and terminal speed, uniform circular motion.

Unit 2 Work, Energy, Collisions

Work, kinetic energy, work-kinetic energy theorem, work done by gravitational and spring forces, power; Work and potential energy, conservative forces, conservation of mechanical energy, potential energy curve; Center of mass, Newton's law for system of particles, linear momentum and its conservation.

Unit 3 Wave motion

Wave motion: Simple Harmonic Oscillation (SHO), differential equation for SHO and its general solution, super position of two or more SHOs, Damped and forced oscillators, resonance. Wave equation, travelling and standing waves in one dimension, energy density and energy transmission in waves, Group velocity and phase velocity.

Unit 4 Geometrical Optics

Review of Geometrical Optics: Fermat's principle, laws of reflection and refraction from Fermat's principle. Refraction at a spherical surface, Linear and lateral magnifications, Refraction through a thick lens. Focal lengths of thick and thin lenses. Combination of two lenses. Cardinal points.
Interference: Wave nature of light, Spatial and temporal coherence, coherent sources, interference of light by division of wave front: Fresnel's biprism, interference of light by division of amplitude: interference in thin films

Unit 5
Fiber Optics

Fiber optics: Introduction to optical fiber, the numerical aperture, coherent bundle, pulse dispersion in step index fiber, graded index fiber, single mode fiber, multimode fiber, fiber optic sensors - examples - fiber optic communication (qualitative), Advantages of fiber optic communication system.

TEXTBOOK:

Halliday, Resnick, and Walker, Fundamentals of Physics, 8th Extended Ed., Wiley Indian Reprint, 2008, Chap. 1-12, 15

REFERENCES:

1. Young and Freedman, University Physics, 11th Ed, Dorling Kindersley India, 2006
2. Halliday, Resnick, and Krane, Physics, Vol. 1, 5th Ed., Wiley Indian Reprint, 2007
3. Feynman, Leighton and Sands, "The Feynman Lectures on Physics", Narosa, 1E, 2008

25CHY103 General Chemistry 3 1 0 4

Course Outcomes

CO01 Understand the foundations for atomic structure using classical mechanics and then by quantum mechanics and use them to solve problems related to energy, shapes and electronic configurations of the atomic orbitals.

CO02 Understand various theories of bonding and apply them to solve i. stability ii. shapes and iii. the reactivity of molecules

CO03 Understand the structure and bonding in crystals

CO04 Understand the various principles of acids and bases and learn chemistry in nonaqueous solvents

CO05 Understand the fundamental principles of chemical analysis and stoichiometric calculations

Unit 1: Atomic structure [14 h]

Bohr's model of hydrogen atom, Ritz combination principle, hydrogen spectrum, Bohr-Sommerfeld theory. Planck's quantum theory of radiation, dual character of electrons - de Broglie's equation, Heisenberg's uncertainty principle, photoelectric effect, Compton, Zeeman and Stark effects. Schrodinger wave equation, Eigen values, significance of wave function (ψ and ψ^2) and quantum numbers. Schrodinger wave equation for hydrogen and hydrogen-like systems, probability distribution of electrons around the nucleus, distribution of electrons in orbitals, shapes of atomic orbitals - s, p, d and f. Aufbau principle, Hund's rule, Pauli's exclusion principle, electronic configuration of elements.

Unit 2: Chemical bonding [16 h]

Electrovalency and ionic bond formation, lattice energy. Born-Lande equation and Born-Haber cycle and their applications, solvation enthalpy and solubility of ionic compounds. Covalent bonding, formation of H_2, orbital theory of covalency. Hybridisation – VSEPR theory, sigma and pi bonds,

formation of covalent compounds. Properties of covalent compounds. Molecular orbital theory – homo diatomic molecules and hetero di and triatomic molecules. Polar and non-polar covalent bonds, polarization of covalent bond - polarizing power, polarisability of ions and Fajan's rule, dipole moment, percentage ionic character from dipole moment, dipole moment and structure of molecules. Co-ordinate covalent compounds and their characteristics. Metallic bond - free electron, valence bond and band theories.

Unit 3: Structure and Bonding in Solids [14 h]

Crystalline and amorphous solids, isotropy and anisotropy, indices - Miller indices, space lattice and unit cell, types of crystals - molecular, covalent, metallic and ionic crystals. Close packing of spheres – hexagonal, cubic and body centered cubic packing – density, coordination numbers, tetrahedral and octahedral holes. Body centered and primitive structures. Interstices in packing. Defects in crystals – stoichiometric, non-stoichiometric, extrinsic and intrinsic defects. Bonding in crystals - metallic, ionic and covalent bonding. Crystal systems - Bravais lattices, reciprocal lattice, interplanar spacing in different crystal systems and fractional coordinates. Ionic solids - structures of MX, MX_2 and MX_3.

Unit 4: Acids, Bases and Non-aqueous solvents [10 h]

Conjugate acids and bases, hard and soft acids and bases - Pearson's concept, HSAB principle and its application. Buffer solutions. Non-aqueous solvents - general characteristics of non-aqueous solvent - melting point, boiling point, latent heat of fusion and vaporization, and dielectric constant. Reactions in non-aqueous solvents like liquid ammonia, liquid SO_2 and liquid HF - complex formation, redox, precipitation and acid base type.

Unit 5: Chemical Analysis and Stoichiometric Calculation [6 h]

Titrimetry - fundamental concepts, theory of indicators. Acid base, redox, precipitation and complexometric titrations. Problems based on stoichiometry. Gravimetry principle and calculations involving estimation of barium, calcium and nickel. Data analysis, significant figures, precision and accuracy. Types of errors, mean and standard deviation.

Recommended Readings

1. Atkins, P. and Overton, T., 2010. Shriver and Atkins' inorganic chemistry. Oxford University Press, USA.
2. Callister Jr, W.D. and Rethwisch, D.G., 2020. Fundamentals of materials science and engineering: an integrated approach. John Wiley & Sons.
3. Catherine E. H. and Alan G. S. 2012. Inorganic Chemistry (Fourth Edition), Pearson, UK.
4. Marion Clyde Day Jr, Joel Selbin, Harry H Sisler. 2012. Theoretical Inorganic Chemistry. LLC.
5. Vogel, A. I. and Jeffery, G.H. 2009. Vogel's Quantitative Chemical Analysis, 6th Ed. Wiley.
6. F. A. Cotton and G. Wilkinson. 1987. Advanced Inorganic Chemistry, 5th edition, John Wiley and Sons, New York.

25CSA104 Introduction to Scientific Computing using Python 3 0 0 3

UNIT 1: Introduction to Python Programming

History of Python Programming Language, thrust areas of Python in physics, Integrated Development Environments, installation and use of python distribution: Anaconda, Spyder, Jupiter notebooks. Fundamental programming with Python - Designing a Program, identifiers, keywords, operators, and expressions. Arithmetic, Logical and Assignment operators, Precedence, Data types: Basic data types:

Strings and numbers, displaying an output, type conversion, basic string operations& methods, format specifiers.

Unit 2: Tuples, Lists & Dictionaries

Tuples: immutable sequences, creating tuple, basic tuple operations. Lists**:** mutable sequences, basic list operations, List methods Dictionaries: basic dictionary operations, dictionary method User input variable.

Unit 3: Control structures

Decision Structures: If, If ----else, if ….elif…..else, nested if decision flow statements.

Repetition Structures: condition controlled: while loop. Count controlled: for loop, sentinals, continue and break statements, try and except statements

Unit 4: Functions & Files

Built in function, modules, void function, flow charting, hierarchy charts, Local variables and scope, passing an argument function, value returning functions, Random number generation

Files: introduction to file input and output

Unit 5: Scientific computing packages

Numpy: -Array object, creating array, matrix, indexing, slicing, resizing, reshaping, arithmetic operations, functions, matrices and vector operations Matplotlib: basic plotting, Scipy: Linear algebra operations, equation solving.

Recommended Readings

1. Mark Lutz, "Learning Python" O'Reilly Media,2013.
2. Robert Johansson, "Numerical Python: Scientific Computing and Data Science Applications with Numpy, SciPy and Matplotlib" Apress, 2019.
3. Rubin H. Landu, Manuel J. Paez, and Cristian C.Bordeianu, "Computational Physics Problem solving with Python" - Third Edition, Wiley VCH, 2015.

❖ Modern Indian Language

24MAL101 Malayalam I LTPC: 2 0 0 2

Course Objectives:

- To enable the students to acquire basic skills in functional language.
- To develop independent reading skills and reading for appreciating literary works.
- Enable students to communicate in the language they have studied in a range of contexts and for a variety of purposes
- To analyse language in context to gain an understanding of vocabulary, spelling, punctuation and speech

Course outcomes:

CO1: Develop the ability to read and critically appreciate a given text

CO2: Develop fluency in speaking the language

CO3: Ability to blend language and Indian spirituality.

Unit	Topic
1	**Adhyatmaramayanam,** Tharopadesam(Enthinnu Sokam….thulom) ---------- **Jnanappana** (sthanamanangal….Trishnakondubhramikkunnathokkeyum)
2	Modern Poets: Mampazham-Vyloppilly Sreedharamenon Critical analysis of the poem.
3	Short stories from period 1/2/3:**Poovanpazham**-Vaikaom Muhammed Basheer

4	Literary Criticism: **Bharatha Paryatanam**-*Vyasante Chiri*–Ithihasa studies-Kuttikrishna Marar-Outline of literary Criticism in Malayalam Literature
5	Error-freeMalayalam: **1**.Language; **2**.Clarity of expression; **3**.Punctuation-Thettillatha Malayalam – Writing-**a**. Expansion of ideas; **b**.PrecisWriting; **c**. Essay Writing

Text books/Reference :

1. Adhyatmaramayanam – Thunjath Ramanujan Ezhuthachan
2. Ramayanavichinthanam-Dr. A. M. Unnikrishnan
3. Thunjan Padhanangal-Prof.Panmana Ramachandran
4. Compleate Works including Jnanappana-Poonthanam
5. Vyloppilly-M.N.Vijayan
6. Vyloppilli-Vyakthi,Kavi-Dr.M.Leelavathi/S.Gupthan Nair
7. Basheerinte Poonkavanam-Prof.M.N.Karasseri
8. Basheer-Life & Works
9. Bharatha Paryatanam-Kuttikrishna Marar
10. Lavanyasastrathinte Yukthisilpam-Dr.Thomas Mathew

11)Thettillatha Malayalam – Prof.Panmana Ramachandran Nair(His all books on Error Free Malayalam)

24HIN101 HINDI I 2 0 0 2

Course Objective: The course will enable the students to understand the basics of grammar and usage, to appreciate the literary compositions, and to understand the intricacies of language and literature.

Course Outcomes: By the end of the course the students will be able to:

1. Distinguish various literary genres.
2. Explore tradition and culture through literature.
3. Apply the basics of grammar.
4. Critically analyse the prescribed literary texts.

UNIT 1

Hindi Sahithya ki Panch shresht Kahaniyam**:**

a.Sughmay Jeevan –Chandradhar Sharma ,Guleri

b.Dhan ki Bhent-Rabindranath Tagore

c.Anbola –Jayashankar Prasad

d.Swamini (Manasrovar bhagh-1) Premchand

UNIT 2.

Hindi Kavitha:

a.'Aarya" –Maithili Sharan Gupth

b. "Meribhi abha he Ismein' .,"Mubarak Ho Naya Saal"-_Nagarjun

c. "Nishaa Ki rod eta Rakesh- Nihar se'.,Shoonya Mandir meinBanoongi-Sandhya Geet se - Mahadevi varma

d.'KhoobLadi Mardani vahtho Jhansi Vali rani thi'-subhadra Kumari chohan

UNIT 3.

Hindi Ekanki**:**

a) Mohan Rakesh :Andeke Chilke

b) Vishnu Prabhakar :Sarkari Noukari

UNIT 4.

Grammar:1)Karak2) Upasarg3)Pratyay4)Vakya Rachana 5)Padaparichay.6)Sarvanam7)kriya 8)Adjective 9)Adverb10)Tenses

REFERENCE

1. Sugam Hindi Vyakarn, :Prof.Vanshidhar & Dharmapal Shastri
2. Vyavaharik Hindi Vyakarantatha Rachana: Dr.Hardev Bahari
Shiksharthi HindiVyakaran:Dr. Nagappa
3. Hindi Sahithya ki Panch shresht Kahaniyam**:** Edited by: Dr.Sachidanandh Shuklu
(Printed and Published by V&S publishers, Abridged, AnsariGanj, Delhi)
4. Hindi Samay.com,/Hindikahani.com/exotic indiaart.com

24KAN101 Kannada I LTPC: 2 0 0 2

Objectives:

- To enable the students to acquire basic skills in functional language.
- To develop independent reading skills and reading for appreciating literary works.
- Enable students to communicate in the language they have studied in a range of contexts and for a variety of purposes
- To analyse language in context to gain an understanding of vocabulary, spelling, punctuation and speech

Course Outcome

CO1	velop the ability to read, listen and write in Kannada and to understand and use the language in a variety of contexts and situations
CO2	enable the learners to understand the grammatical structures of classes of words
CO3	velop ability to speak fluently and interactively in both personal and professional context

Course Contents

UNIT – 1

Adalithadalli Kannadada balake: (Use of Kannada in business and administration)
Bhashe – swaroopa, stityantaragalu,
Aadu bhashe, pradeshika bhashe, Grantika bhashe
Paaribhaashika padagalu

UNIT – 2

Padagala rachane,deshiya – anya deshiya padagalu
Lekhana Chinnhegalu
Kannada bharavanigeya shuddha mattu ashuddha roopagalu,
Dwiruktigalu, jodunudigalu

UNIT – 3

Nudigattgalu, gaade vistarane
Listening to radio speech, tongue twister - practice

UNIT – 4

Patra Lekahna - aupachaarika haagu anoupachaarika
Kandikegala rachane
Prabandhagalu: vivaranaatmaka haagu niroopanatmaka

UNIT – 5

Poems

- Vachanagalu – kaalugalembavu gaali kandaya – Allamaprabhu,Ratnada sankoleyaadade todarallve – Akkamahadevi, ole hatti uridare nilabahudallade - Basavanna
- Keerthanegalu – Tanuva nirolagaddi phalavenu – Purandaradasa, Tallanisadiru kandya taalu manave - Kanakadaasa
- Tripadigalu – Saalavanu kombaaga haalogarundante - Sarvagna
- Janapada geetegalu - Yaake badtaadti tamma

Short stories

- Sambhanda – Shrikrishna Alanahalli
- Moksha – Sethuram

Prabandhagalu

- Namma Maneya Deepa – Ha.Ma.Nayak
- Bhadhuku Kanasalla, Ondhu Kale – N K Kulakarni

References:

1. H.S.Krishnaswamy Iyangaar – Adalitha Kannada – Chetana publication, Mysuru
2. Kannada Vyakarana mattu Rachane – N.Gopalakrishna Udupa, M.C.C.Publication
3. G.H.Naayak – Kannada Sanna Kathegalu – Chetana Book House
4. Shatamaanada Lalitha Prabandha – Gurulinga Kaapase - Karnataka Sahitya Academy
5. Naavalla – Kathasankalana – Sethuram
6. Basavannanavara Vachanagalu – G.V.Shastri – Paaru prakashana
7. Kannadada Balake – H.S.Krishnaswamy Iyangaar – Chetana book house
8. Sarvagnana Vachanagalu – Venkata Subbaiha, Vijayavaahini Publications

24SAN101 **SANSKRIT I** **2 0 0 2**

Course Objectives:

- To enable the students to acquire basic skills in functional language
- To develop independent reading skills and reading for appreciating literary works.
- To analyse language in context to gain an understanding of vocabulary, spelling, punctuation and speech
- Grasp the connection between Sanskrit language and Indian philosophy

Course Outcomes:

CO 1 Read and understand Sanskrit verses and sentences and communicate in Sanskrit

CO 2 Imbibe values of life and Indian tradition propounded by the scriptures

Module I

Introduction to Sanskrit language, Devanagari script - Vowels and consonants, pronunciation, classification of consonants, conjunct consonants, words – nouns and verbs, cases – introduction, numbers, Pronouns, communicating time in Sanskrit. Practical classes in spoken Sanskrit

Module II

Verbs- Singular, Dual and plural — First person, Second person, Third person.

Tenses – Past, Present and future – Atmanepadi and parasmaipadi-kartharipraYoga.

Module III

General group words for communication and moral stories.

Module IV

ChanakyaNeeti chapter III (part I), Bhagavad Gita chapter 14 (part I)

Module V

Translation of simple sentences from Sanskrit to English and vice versa.

24TAM101	**TAMIL I**	**2 0 0 2**

Course Objectives:

To teach Tamil for effective communication in different spheres of life: - cultural relations in society.

Course Outcomes:

1. Giving exposure to history of Tamil literature and Introduction of select Classics
2. Initiating Students to the spirit of Bhakti literature
3. Encouraging creativity of students by teaching Contemporary Literature poetry, modern poetry, Short Story, Prose, Novel, etc
4. Introduction of basic Grammar, Letter writing and essay writing skills of Tamil language.

அலகு-1

தமிழ்இலக்கியவரலாற்றில்சங்கஇலக்கியம்: முதல், இடை, கடைசங்கம்.

சங்கஇலக்கியங்கள்பத்துப்பாட்டு.

குறுந்தொகை (6,8பாடல்கள்),

புறநானூறு (184,192பாடல்கள்).

சங்கம்மருவியகாலஇலக்கியம்:

சிலப்பதிகாரம் (வழக்குறைக்காதை),

பதிணெண்கீழ்கணக்குநூல்கள்,

திருக்குறள் (மருந்து)

UNIT-1 History of Tamil Literature: First, Intermediate, Last sangam. Sangam Literature, Pattuppaattu. Kuṟuntogai, Puṟanaanuuru.

Literature of the Sangam Maruviya period – Silappathiagaram (vazhakkuraikaathai), PatiṇeṇkiizhKaṇakkuNuulkal. TirukkuṟaL (Marunthu)

அலகு 2

பக்திஇலக்கியம்:–

பன்னிருதிருமுறைகள்அறிமுகம்,

மாணிக்கவாசகர் (திருவாசகம்- சிவபுராணம்)

UNIT 2 Bhakti Literature – Introduction to PanniruThirumuraikal, Manikkavasagar (Thiruvasagam- Siva Puranam)

அலகு -3

தற்காலஇலக்கியம்:-

கவிதை : பாதியார் (குயில்பாட்டு), பாரதிதாசன் (தமிழின்இனிமை).

உரைநடை: ஞா.தேவநேயப்பாவாணர் (தமிழும்திரவிடமும்சமமா?),
பரிதிமாற்கலைஞர் (தமிழ்மொழியின்வரலாறு (ஆதிவரலாறு)).
சிற்பி (வள்ளுவர்வகுக்கும்இன்பம்)

சிறுகதை: அழகியபெரியவன் – (வனம்மாள்)

நாவல்: இமையம் (பெத்தவன்)

UNIT-3 Contemporary Literature: Poetry - Bharathiar(kuyilpāṭṭu), Bharathidasan (tamiḻiṉiṉimai, iṉpattamiḻ) Pattukottai Kalyanasundaram.

Prose: G. DevaneyaBhavanar (TamizhumDhiravidamumsamamaa?), Paritimāṟkalaiñar (paranarkettaparisu), chirbi (valluvarvakukkuminbam)
Short Story: Azhagiya Periyavan – (VanammaaL)
Novel: Imaiyam (Peththavan)

அலகு – 4தொல்காப்பியம்:

எழுத்து – பிறப்பியல்.
நிறுத்தக்குறிகள்மற்றும்
கடிதம்எழுதுதலும்கட்டுரைஎழுதுதலும்

UNIT – 4tolkāppiyam: Alphabet – piṟappiyal. Punctuation marks and Letter writing and essay writing.

REFERENCE

இமையம், *பெத்தவன்*, க்ரியாவெளியீடு 2019.
அழகியபெரியவன் ,*அழகியபெரியவன்கதைகள்*, நற்றிணைபதிப்பகம், 2016
சி.பாலசுப்பிரமணியன், *கட்டுரை-வளம்*, நறுமலர்ப்பதிப்பகம், பத்தாம்பதிப்பு 1994
பரிதிமாற்கலைஞர் ,*தமிழ்மொழியின்வரலாறு*, பூம்புகார்பதிப்பகம், ஆறாம்பதிப்பு 2013.
அகளங்கன், *பன்னிருதிருமுறை – அறிமுகம்*, இந்துமாமன்றம்வவுனியா, 1994
ரா. சீனிவாசன ,*தமிழ்இலக்கியவரலாறு* ,https://ta.wikisource.org/s/99uk
மாணிக்கவாசகர் (திருவாசகம்- சிவபுராணம்
பொன்மணிமாறன் "அடோன்தமிழ்இலக்கணம் "அடோன்பப்ளிஷிங்குரூப், வஞ்சியூர், திருவனந்தபுரம், 2007.
http:/www.tamilvu.org/libirary/libindex.htm.
http:/www.gunathamizh.com/2013/07/blog0post_24.html

25PHY181 **Physics Lab. I** **0 0 2 1**

Course Outcomes:

CO1: Develop the ability to impart useful knowledge in real-world situations.
CO2: Apply measurement techniques, innovative instrument usage, and their practical applications.
CO3: Recognize the ideas, methods, and applications of fundamental problems in physics, and compare the outcomes to theoretical calculations.
CO4: Conduct some fundamental tests in optics and mechanics and to verify the outcomes.

List of experiments:

1. Surface Tension – Capillary Rise Method.
2. Coefficient of Viscosity - Stoke's Method.
3. The Torsion Pendulum.

a. Moment of Inertia of the Disc.

b. The Rigidity Modules of the Material of Wire.

4. Young's Modulus – Uniform Bending.
5. Spectrometer – Dispersive Power.

6. Liquid Lens – Refractive index of liquid.
7. Laser - Wave length of Laser beam.
8. Laser - Slit Width of the given slit.
9. Magnetometer – Measurement of magnetic flux

24ENV200 ENVIRONMENTAL SCIENCE AND SUSTAINABILITY 3 1 0 4

Course Objective:
To provide a general understanding of our environment, problems during exploitation of natural resources, the importance of biodiversity and the need for its conservation, pollution and its impacts, and approaches for environment sustainability.

Course Outcomes:
The student will be able to:

- CO1: Understand the over-exploitation of our natural resources and the need for Sustainable development.
- CO2: Understand the concept of ecosystem, its structure and function and threats to Ecosystems.
- CO3: Understand the concept of bio-diversity, its importance and conservation.
- CO4: Classify pollution and its impacts
- CO5: Inferring different approaches for attaining environmental sustainability.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15
CO1	0	0	0	1	1	1	0	1	1	1	1	1	1	0	0
CO2	1	1	0	1	1	1	1	1	2	1	1	1	1	1	1
CO3	1	1	0	1	1	1	1	1	2	1	1	1	1	1	1
CO4	2	2	0	1	1	1	1	1	2	1	1	1	1	1	1
CO5	2	2	1	2	2	2	1	2	2	1	1	1	1	2	2

Unit 1
Multidisciplinary nature of environmental studies, Renewable and non-renewable Natural resources, Overexploitation and conservation of the following natural resources: forest, water, food, energy, mineral and land resources, Concept of sustainability, sustainable development, Concept of three R's (Reduce, Reuse, and Recycle), Concept of zero waste, Need for environmental education.

Unit 2
Concept of ecosystem. Components, structure and function of an eco-system, A brief description of forest ecosystem and desert ecosystem, Food chain and food web, Ecological Pyramids, Biogeochemical Cycles (examples-Carbon, Nitrogen and Phosphorous), Ecosystem Services (example forest), Threats to ecosystems, Conservation of ecosystems.

Unit 3

Concept of Biodiversity, hot spots of biodiversity, India as a mega diversity nation, Threats tobiodiversity, Value of biodiversity, Brief description of economic valuation of biodiversity, RedData Base and Red data Book, International Union for Conservation of Nature (IUCN), Red List of Threatened Species (Brief description), Conservation of biodiversity.

Unit 4

Pollution of air, acid rain, global warming and climate change, ozone layer depletion, Water pollution, Soil pollution. Industrial and urban solid wastes, Hospital wastes, Hazardous waste,Collection, segregation of solid wastes, Different household disposal methods for degradable solid wastes, Commercial water purification devices for households, Plastic pollution, microplastics and its environmental and health effects, E-waste.

Unit 5

Ecological foot prints, brief description of Carbon Footprint and Water Footprint, Linear and Circular resource management, System thinking, Industrial ecosystems, Environmental ImpactAssessment (EIA), Environment Management Plan (EMP), Green Technology, Green Business, Green Accounting, Green Buildings, Eco-Labeling, Sustainable (Green) Cities, Roleof individuals in the up keeping of environment.

Text Books:

Palanisamy P. N., Manikandan P., Geetha A., Manjula Ran – Environmental Science - PearsonEducation.
Harikumar P.N., Susha D. And Manoj Narayanan K. S. – Environment management and humanrights - Himalaya Publishing House.
Asthana D.K and Meera Asthana – A Textbook of Environmental Studies - S. Chand &Company

References:

Bala Krishnamoorthy – Environmental Management: Text and Cases - PHIJacob Thomas – Environmental management: Text and Cases - Pearson.
Rajagopalan R. – Environmental Studies: From crisis to cure - Oxford University Press

22ADM101 Foundations of Indian Heritage 2 0 1 2

UNIT 1

Introduction to Indian Culture - Introduction to Amma's life and Teachings – Symbols of Indian Culture.

UNIT 2

Science and Technology in Ancient India - Education in Ancient India - Goals of Life – Puru sharthas - Introduction to Vedanta and Bhagavad Gita.

UNIT 3

Introduction to Yoga - Nature and Indian Culture - Values from Indian History – Life and work of Great Seers of India.

TEXTBOOKS:

1. The Glory of India (in-house publication)

2. The Mother of Sweet Bliss, (Amma's Life & Teachings

SEMESTER 2

25MAT111 Differential Equations and Transforms 3 0 0 3

Course Outcomes:

CO1: Analyze linear and nonlinear differential equations and solve ordinary differential equations of first order.
CO2: Apply various techniques to solve second-order linear homogeneous and nonhomogeneous, differential equations
CO3: Explore Laplace Transforms, properties of Laplace Transform, inverse Laplace Transform, and some of its applications to solve differential equations.
CO4: Apply and solve problems on Fourier series, Fourier integrals, and Fourier Transforms.
CO5: Employ partial differential equations to solve Heat and Wave equations using Fourier series.

Unit 1
Ordinary Differential Equations: First Order Differential Equations - Basic concepts, Exact ODEs, and Integrating factors, Linear differential equations of the first order.

Unit 2
Second Order Differential Equations - linear homogeneous ODE of second order with constant coefficients. Euler-Cauchy Equations. Solution of second-order linear non-homogeneous ODE by the method of Undetermined Coefficients and by the method of Variation of Parameters.

Unit 3
Laplace Transform: Laplace Transforms, Inverse Transforms, Linearity, s-shifting, Transforms of Derivatives and Integrals, Unit Step Function, t-shifting, partial fractions, solution of initial value problems and system of Differential Equations.

Unit 4
Fourier Series and Fourier Transform: Fourier series, Half range Expansions, Fourier Integrals, Fourier Sine, and Cosine Integrals. Fourier Transforms, Sine and Cosine Transforms, Properties.

Unit 5
Partial Differential Equations: Basic Concepts, Modeling, Vibrating String, Wave Equation, Separation of Variables, solution by Fourier Series. Heat Equation, Solution by Fourier Series.

TEXTBOOK:
1. Advanced Engineering Mathematics, Erwin Kreyszig, Wiley India, Tenth Edition, 2015.

REFERENCE BOOKS:
1. George Turrell, Mathematics for Chemistry and Physics, Academic Press, 2002.
2. Robert G. Mortimer, Mathematics for Physical Chemistry, 3rd Edition, Elsevier, 200

25PHY112 Electricity and Magnetism 3 0 0 3

Course Outcomes:

CO1: Apply the fundamental laws of electrostatics to calculate the electric field and electric potential.
CO2: Apply the physics of capacitors, resistance and develop skills to solve various electric circuits.
CO3: Analyze the basic concepts regarding semiconductor p-n junction devices
CO4: Evaluate the basic concept and working of Field Effect Transistors and operational amplifiers.
CO5: Assess the digital electronics and logic gates

Unit 1 Electric forces and fields

Electric forces, charges, conservation of charge, superposition of electric forces; electric fields, calculation of electric fields of static discrete and continuous charge distributions; Gauss' law and determination of electric fields of simple symmetric charge distributions.

Unit 2 Electric potential and Capacitors

Electrical potential energy and electric potential of discrete and continuous distributions of charges; calculating electric field from potential; potential energy of system of point charges; capacitors and dielectrics.

Unit 3 Basic Electronics

Conduction in metals, semiconductors and insulators, intrinsic semiconductors, n and p mate-rials, conduction by drift and diffusion, The p-n junction, Fermi level ofpn junction, diode equation, Hall effect, diode characteristics, capacitance of a p-n junction, rectification, recti-fier configurations for power supplies, circuit applications of a diode-as a switch, clipping, clamping, different types of diodes - Zener diodes, LEDs, diode lasers, photodiodes, etc.

Voltage and current - resistors, voltage dividers, voltage and current sources, Thevenin's the-orem, sinusoidal signals, signal amplitudes and decibels, other signals, logic levels, signal sources.

Unit 4 Transistors

Transistors - npn and pnp, transistor characteristics - CB, CE and CC configurations, relation between a, b and g, transistor switch, transistor biasing. Feedback circuits. Transistor action, emitter follower, Transistor applications as amplifier. RC coupled amplifier.

Unit 5 Digital Electronics

Digital electronics: Digital versus analog, logic gates, truth table, discrete circuits for gates, logic identities, minimization and Karnaugh maps. Basics of integrated circuit (IC).

TEXTBOOK:

Bernar Grob and Mitchel. E. Schultz, Basic Electronics (9th Edition), Tata Mc.Graw Hill, New Delhi (2003)

REFERENCES:

1. John D.Ryder, Electronic Fundamentals and Applications, Prentice Hall of India Pvt.Ltd. New Delhi (1983).

2. Albert Paul Malvino, Digital Computer Electronics Tata McGraw Hill Pub. Co. Ltd New Delhi (1983)

3. Horowitz and Hill, The art of Electronics (Cambridge University press)

25CHY113 Principles of Inorganic Chemistry 3 1 0 4

CO01 understand the general characteristics of elements in the periodic table

CO02 analyze the preparation and properties of various compounds of s, p, d, f block elements.

CO03 explore the application of various compounds and complexes for industrial and research purposes.

CO04 apply the principles of different metallurgical processes adopted for the extraction of different elements in the periodic table.

CO05 gain a thorough understanding of various types of inorganic reactions and their mechanisms.

CO06 apply the basic concepts of nuclear and radiation chemistry for its application in energy and chemical analysis perspectives.

Unit 1: Periodic Properties and s-Block Elements [12 h]

Periodicity in properties – atomic, ionic, covalent radii, ionization potential, electron affinity, electronegativity, effective nuclear charge – Slater's rule and their trends in periodic table. s-block elements - general characteristics – atomic and ionic radii, ionization energy, electropositive character, reducing property, hydration of ions, flame coloration, lattice energy, diagonal relationship and chemical properties. Ellingham diagram - extraction of alkali and alkaline earth metals. Uses of alkali and alkaline earth metals, synthesis and applications of compounds and complexes.

Unit 2: p Block Elements [15 h]

General characteristics – metallic and non-metallic character. Extraction of p-block elements. Boron compounds - Lewis acids and back bonding. Graphite, intercalation compounds, carbides, silicates and silicones and their applications. Allotropy in P and S. Compounds of N and P. Anomalous behavior of second row elements. Structure of ozone. Hydrides, halides, oxides, oxoacids, persulfuric acids and nitrides of group VI and VII elements. Interhalogen compounds and their structure. Isolation of noble gases. Preparation, properties, structure and uses of noble gas compounds.

Unit 3: d Block Elements [10 h]

Transition metals - general characteristics, metallic character, oxidation states, size, density, melting and boiling points, ionization energy, color, magnetic properties-spin only magnetic moments, reducing properties and catalytic properties. Nonstoichiometric compounds, complex and alloy formation. Difference between first and other two rows of d block elements and their compounds. Extractive metallurgy – Ellingham diagram. Compounds of transition metals (other than coordination compounds).

Unit 4: f Block Elements [8 h]

Position in the periodic table, general characteristics of lanthanides and actinides. Lanthanide contraction and its consequences. Isolation of lanthanides from monazite - ion exchange resin method. Actinides – occurrence, preparation and comparison with lanthanides. Uranium, thorium and plutonium - important compounds - preparation, properties and uses.

Unit 5: Nuclear Chemistry [15 h]

Nuclear structure, mass and charge, mass defect, binding energy, stability rules, magic numbers, nuclear quantum numbers and nuclear parity. Models of nucleus, shell model, liquid drop model, semi empirical mass equation, equations of radioactive decay and growth, half-life and average life. Determination of half-lives. Types of nuclear reactions. Radiation chemistry - radiochemical methods, measurement of radioactivity, measurement of radiations – gas detector, scintillation counter and semiconductor detectors. Applications of nuclear and radiation chemistry, isotope dilution analysis, activation analysis, radiometric titrations, radiation dosimetry, hydrated electron. Effective utilisation of nuclear energy – nuclear reactors.

Recommended Readings

1. Atkins, P. and Overton, T., 2010. Shriver and Atkins' inorganic chemistry. Oxford University Press, USA.
2. Housecroft, C.E. and Sharpe, A.G., 2008. Inorganic chemistry (Vol. 1). Pearson Education.
3. Lee, J.D., 2008. Concise inorganic chemistry. John Wiley & Sons.
4. Douglas, B.E., McDaniel D. and Alexander J. 2000. Concepts and models of inorganic chemistry. Wiley.
5. Arnikar, H.J., 1995. Essentials of nuclear chemistry (No. 1653). New Age International.
6. Source book on atomic energy, Glaston
7. Huheey, J.E., Keiter, E.A., Keiter, R.L. and Medhi, O.K., 2006. Inorganic chemistry: principles of structure and reactivity. Pearson Education India.
8. Cotton, F.A., Wilkinson, G., Murillo, C.A. and Bochmann, M., 1999. Advanced inorganic chemistry. John Wiley and Sons, Inc.

25CHY114 Principles of Physical Chemistry 3 1 0 4

CO01 Solve conceptual and numerical problems, in line with the science of 'gaseous state'

CO02 Analyze and interpret the bulk behaviour of systems, in line with the principles of classical thermodynamics

CO03 Apply the substantial knowledge of both fundamental and applied aspects of chemical kinetics

Unit 1: Gaseous state [14 h]

Kinetic theory of gases, ideal gas equation, Maxwell distribution of energy and velocities, collision parameters. Relation between mean free path and coefficient of viscosity. van der Waals equation, other state equations, law of corresponding states, liquefaction, Andrews curves, critical parameters, methods for liquefaction. Critical phenomena, critical constants and their determination.

Unit 2: Thermodynamics – I [13 h]

Thermodynamic processes - reversible and irreversible, isothermal and adiabatic processes. State and path functions. Exact and inexact differentials, concept of heat and work. First law of thermodynamics. Relation between Cp and Cv. Calculation of w, q, dE and dH for expansion of ideal and real gases under isothermal and adiabatic conditions of reversible and irreversible processes. Thermochemistry - Enthalpy change of a reaction and different enthalpy changes - relation between enthalpy of reaction at constant volume and at constant pressure. Temperature dependence of heat of reaction - Kirchhoff's equation. Bond energy and its calculation from thermochemical data - integral and differential heats. Numerical problems.

Unit 3: Thermodynamics-II [12 h]

Second law of thermodynamics - different statements of the law, Carnot's cycle and efficiency of heat engine, Carnot's theorem. Thermodynamic scale of temperature - concept of entropy - definition and physical significance of entropy - entropy as a function of P, V and T. Entropy changes during phase changes, entropy of mixing. Entropy criterion for spontaneous and equilibrium processes in isolated system, Gibb's free energy (G) and Helmholtz free energy (A) - variation of A and G with P, V and T – Gibb's - Helmholtz equation and its applications. Thermodynamic equation of state – Maxwell's relations. Numerical problems.

Unit 4: Thermodynamics – III [7h]

Third law of thermodynamics - need for third law, calculation of absolute entropy, unattainability of absolute zero, thermodynamic systems of variable composition. Fugacity functions, partial molar quantities, thermodynamics of ideal solutions, real solutions and regular solutions, dilute solutions of nonelectrolytes, Henry's law, Raoult's law, Gibbs-Duhem equations, Gibbs-Duhem-Margules equations, and activity and standard states of non-electrolytes. Numerical problems.

Unit 5: Chemical Kinetics [14 h]

Molecularity and order of a reaction, rate law expression and rate constant. First, second, third and zero order reactions, pseudo-first order reactions (pseudo-unimolecular reactions). Effect of temperature on reaction rates - Arrhenius equation and its derivation, activation energy, characteristics of activated complex. Theories of reaction rates – collision theory – derivation of rate constant of bimolecular gases reaction – failure of collision theory – Lindemann's theory of unimolecular reaction. Theory of absolute reaction rates – derivation of rate for a bimolecular reaction. Eyring equation – significance of entropy and free energy of activation. Equilibrium and steady state approximations, Kinetics of parallel, chain, opposing and consecutive reactions. - mechanism of these reactions.

Recommended Readings

1. Atkins, P., Atkins, P.W. and de Paula, J., 2006. Atkins' physical chemistry. Oxford university press.
2. Gilbert William Castellan. 1983. Physical Chemistry, Addison Wesley; 3rd revised edion
3. Ira Levin, 'Physical Chemistry', 6th edition, Tata Mcgraw-Hill Education, 2011.
4. Samuel Glasstone, Textbook of Physical Chemistry, , Macmillan; 2nd edition.
5. Keith J Laidler, Chemical Kinetics, Pearson Publications, Third edition, 2003
6. James E House, Principles of Chemical Kinetics, Second Edition, Academic Press, 2007
7. Silbey, Alberty and Bawendi, Physical Chemistry, Fourth Edition, John Wiley and Sons

25PHY182 Physics Lab II 0 0 2 1

Course Outcomes:

CO1: Establish a theoretical framework for the lecture-introduced notions through experimentation.
CO2: Apply the ideas and methods that are widely used in experimental research that could be directly related to the theoretical principles studied throughout the course.
CO3: Examine and interpret the principles of thermal physics, magnetism, mechanics, optics and electronics.
CO4: Develop their capacity for independent thought and problem-solving through a curriculum that emphasizes research.

List of experiments:

1. Lee's disc – Thermal Conductivity of a bad conductor.
2. Solar cell characteristics.
3. Potentio meter – Comparison of emfs.
4. Conversion of galvanometer to Voltmeter.
5. Field along the axis of a coil.
6. Measurement of Laser beam divergence.
7. Spectrometer - i – d – curve.
8. Newton's rings.
9. Meter bridge - Resistance measurement.
10. Ref. index of a Transport bar.
11. Elective field distribution

25CHY181 Chemistry Lab - I 0 0 3 1

CO1: Obtain thorough understanding of analytical procedures utilized in volumetry and gravimetry analysis

CO2: Develop analytical skills in estimating inorganic ions in solutions

CO3: Acquire systematic knowledge in the preparation of analytical reagents, handling of chemical reagents, glassware's and basic equipment's

CO4: Obtain thorough knowledge in the usage of different solution concentration terms employed in analytical chemistry

CO5: Acquire hands of experience in the usage of variety of chemical reactions employed in analytical chemistry

1. Estimation of sodium hydroxide and sodium carbonate in a mixture by double indicator method.
2. Estimation of calcium permanganometry
3. Estimation of Ferrous iron permanganometry
4. Estimation of ferrous iron using external and internal indicators.
5. Estimation of ferric iron using external and internal indicators.
6. Estimation of copper sulphate by iodometry titration
7. Estimation of iron in the given sample of haematite
8. Gravimetric estimation of barium as barium sulphate.
9. Gravimetric estimation of sulphate as barium sulphate.
10. Gravimetric estimation of copper as copper (I) thiocyanate.
11. Gravimetric estimation of nickel as nickel dimethyglyoximate.

24ENG101 English I 2 0 0 2

Objectives:

To help students obtain an ability to communicate fluently in English; to enable and enhance the students' skills in listening, speaking, reading, and writing; to impart an aesthetic sense and enhance creativity

Cos	Course Outcomes
CO 1	Demonstrate competence in the mechanics of writing
CO 2	Summarise audio and written texts to convey messages effectively
CO 3	Apply mechanics of writing and AI tools to draft academic and professional documents
CO4	Organise ideas and thoughts for clear written and oral communication
CO 5	Critically evaluate literary texts

Unit I

Mechanics of writing - Parts of speech – use of prepositions, adjectives, adverbs and determiners – word order – collocation – concord (Subject-Verb, Pronoun-Antecedent) – kinds and patterns of sentences

Unit II

Tenses - Modal auxiliaries - Reported speech - Active and Passive Voice - Phrasal Verbs - Linkers/ Discourse Markers - Question Tags

Unit III

Pre-writing techniques - Paragraph writing – Cohesion – Development – types: definition, comparison, classification, contrast, cause and effect - Essay writing: Descriptive and Narrative - Introduction to the use of Gen AI in writing (AI tools, Do's and Don'ts while using AI, how to write prompts, etc.)

Unit IV

Listening comprehension (3 pieces – Do Schools kill creativity? By Sir Ken Robinson, Steve Jobs' 2005 Stanford Commencement Address, India Questions Dr Abdul Kalam- Aired August 2007) - Reading Comprehension – Skimming and Scanning- Inference and Deduction – Reading different kinds of material – Speaking**:** Narration of incidents / stories/ anecdotes.

Unit V

Shashi Tharoor – "'Kindly Adjust' to Our English
A. G. Gardiner – "A Fellow Traveller"
Ruskin Bond – "The Eyes Have It"
Mrinal Pande – "Girls"

W. H. Auden – "Unknown Citizen"
W H Davies - "Leisure"

References:

1. Murphy, Raymond, *Murphy's English Grammar,* CUP, 2004
2. Syamala, V. *Speak English in Four Easy Steps*, Improve English Foundation Trivandrum: 2006
3. Martinet, Thomson, *A Practical English Grammar*, IV Ed. OUP, 1986.
4. The Week - June 03, 2018, LAST WORD; https://www.theweek.in/columns/shashi-tharoor/2018/05/25/kindly-adjust-to-our english.html?fbclid=IwAR3IhtdXqvuV4ySECn9S7SA6HmCEYISyd1QHd3BlwKgiNKKwdkeSg3qWp-U/
5. A G Gardiner – *Leaves in the Wind*, Digicat (e-book), 2015
6. Ruskin Bond – *The Best of Ruskin Bond*; India Penguin. April 2016.
7. Mrinal Pande – *Stepping Out*; Penguin India; 2003
8. W H Auden – *Another Time*; Random House Pub; 1940
9. William H Davies – *Songs of Joy and Others*; Andesite Press, August 2017.
10. Sir Ken Robinson – "Do schools kill creativity?". https://go.ted.com/6WoC
11. Steve Jobs' 2005 Stanford Commencement Address. https://youtu.be/UF8uR6Z6KLc?si=1nMNYJOk3Yw7H7tF
12. India Questions Dr Abdul Kalam (aired: August 2007). https://youtu.be/erg3CmVm6M4?si=YudsxXZOFY1do91C

22ADM111 Glimpses of Glorious India 2 0 1 2

Unit 1

1. Relevance of Sri Rama and Sri Krishna in this Scientific Age
2. Lessons from the Epics of India
3. Ramayana & Mahabharata

Unit 2

4. Who is a Wise Man?
5. A Ruler's Dharma
6. The Story of King Shibi

Unit 3

7. Introduction to the Bhagavad Gita
8. Bhagavad Gita – Action without Desire

Unit 4

9. Role and Position of Women in India
10. The Awakening of Universal Motherhood

Unit 5

11. Patanjali's Astanga - Yoga System for Personality Refinement
12. Examples of Heroism and Patriotism in Modern India

Recommended Readings

1. Common Resource Material II (in-house publication)
2. Sanatana Dharma - The Eternal Truth (A compilation of Amma's teachings on Indian Culture)

22AVP103 Mastery Over Mind (MAOM) 1-0-2 2

1. Course Overview

Master Over the Mind (MAOM) is an Amrita initiative to implement schemes and organise university-wide programs to enhance health and wellbeing of all faculty, staff, and students (UN SDG -3). This program as part of our efforts for sustainable stress reduction gives an introduction to immediate and long-term benefits and equips every attendee to manage stressful emotions and anxiety facilitating inner peace and harmony.

With a meditation technique offered by Amrita Chancellor and world-renowned humanitarian and spiritual leader, Sri Mata Amritanandamayi Devi (Amma), this course has been planned to be offered to all students of all campuses of AMRITA, starting off with all first years, wherein one hour per week is completely dedicated for guided practical meditation session and one hour on the theory aspects of MAOM. The theory section comprises lecture hours within a structured syllabus and will include invited guest lecture series from eminent personalities from diverse fields of excellence. This course will enhance the understanding of experiential learning based on university's mission: "Education for Life along with Education for Living", and is aimed to allow learners to realize and rediscover the infinite potential of one's true Being and the fulfilment of life's goals.

2. Course Syllabus

Unit 1 (4 hours)

Causes of Stress: The problem of not being relaxed. Need for meditation -basics of stress management at home and workplace. Traditions and Culture. Principles of meditation– promote a sense of control and autonomy in the Universal Human Value System. Different stages of Meditation. Various Meditation Models. Various practices of Meditation techniques in different schools of philosophy and Indian Knowledge System.

Unit 2 (4 hours)

Improving work and study performance. Meditation in daily life. Cultivating compassion and good mental health with an attitude of openness and acceptance. Research and Science of Meditation: Significance of practising meditation and perspectives from diverse fields like science, medicine, technology. philosophy, culture, arts, management, sports, economics, healthcare, environment etc. The role of meditation for stress and anxiety reduction in one's life with insights based on recent cutting-edge technology. The effect of practicing meditation for the wholesome wellbeing of an individual.

Unit 3 (4 hours)

Communications: principles of conscious communication. Relationships and empathy: meditative approach in managing and maintaining better relationships in life during the interactions in the world, role of MAOM in developing compassion, empathy and responsibility, instilling interest, and orientation to humanitarian projects as a key to harness intelligence and compassion in youth. Methodologies to evaluate effective awareness and relaxation gained from meditation. Evaluating the

global transformation through meditation by instilling human values which leads to service learning and compassion driven research.

TEXT BOOKS:

1.Mata Amritanandamayi Devi, "Cultivating Strength and vitality," published by Mata Amritanandamayi Math, Dec 2019
2.Swami Amritaswarupananda Puri ,"The Color of Rainbow " published by MAM, Amritapuri.

REFERENCES:

1.Craig Groeschel, "Winning the War in Your Mind: Change Your Thinking, Change Your Life" Zondervan Publishers, February 2019
2.R Nagarathna et al, "New Perspectives in Stress Management "Swami Vivekananda Yoga Prakashana publications, Jan 1986
3. Swami Amritaswarupananda Puri "Awaken Children Vol 1, 5 and 7 - Dialogues with Amma on Meditation", August 2019
4. Swami Amritaswarupananda Puri "From Amma's Heart - Amma's answer to questions raised during world tours" March 2018
5. Secret of Inner Peace- Swami Ramakrishnananda Puri, Amrita Books, Jan 2018.
6. Mata Amritanandamayi Devi "Compassion :The only way to Peace:Paris Speech", MA Center, April 2016.
7. Mata Amritanandamayi Devi "Understanding and collaboration between Religions", MA Center, April 2016.
8. Mata Amritanandamayi Devi "Awakening of Universal Motherhood: Geneva Speech" M A center, April 2016.

3. Evaluation and Grading

Internal			**External**	**Total**
Components	*Weightage*		Practical (attendance and class participation) 60%	100%
Quizzes(based on the reading material)	20%	40%		
Assignments (Based on webinars and lecture series)	20%			

4. Course Outcomes (CO)

CO1: Relate to the causes of stress in one's life.
CO2: Experiment with a range of relaxation techniques CO3: Model a meditative approach to work, study, and life.
CO4: Develop appropriate practice of MA-OM technique that is effective in one's life CO5: Inculcate a higher level of awareness and focus.
CO6: Evaluate the impact of a meditation technique

***Programme Outcomes(PO)**(As given by NBA and ABET)

PO1: Engineering Knowledge
PO2: Problem Analysis
PO3: Design/Development of Solutions

PO4: Conduct Investigations of complex problems
PO5: Modern tools usage
PO6: Engineer and Society
PO7: Environment and Sustainability
PO8: Ethics
PO9: Individual & Team work
PO10: Communication
PO11: Project management & Finance
PO12: Lifelong learning

CO – PO Affinity Map

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1	3	3	3	2		-	2	3	-	3	-	3	-	-	-
CO 2	3	3	3	2	2	_	2	3	3	3	-	3	-	-	-
CO 3	3	3	2	2	2	2	2	3	3	3	-	3	-	-	-
CO 4	3	3	3	2	-	2	3	3	3	3	-	3	-	-	-
CO 5	3	2	2	2	-	2	-	3	2	2	-	2	-	-	-
CO 6	3	2	2	2	3	2	_	3	2	2	-	2	-	-	-

SEMESTER II

24ENG111 English II 1 0 2 2

Objectives:

To train students to convey and document information in a formal environment; to facilitate them to acquire the skill of self-projection in professional circles; to inculcate critical and analytical thinking.

Cos	Course Outcomes
CO 1	Illustrate comprehension of the fundamentals of writing
CO 2	Analyse audio text focussing on English phonetics, pronunciation and meaning comprehension
CO 3	Apply theoretical knowledge to write professional documents
CO 4	Infer from current news to formulate ideas and opinions
CO5	Prepare appropriate content for mini project and make effective presentation

Unit I

Vocabulary Building: One-word substitutes; Antonyms and Synonyms; Words often Confused Error Analysis (Subject-Verb Agreement; Tense Sequence; Usage of Articles and Prepositions; Determiners; Redundancy); Modifiers (misplaced**,** dangling, etc.)

Unit II

Circulars; Memos; Formal Letter writing; e-Mail Etiquette; Instruction, Suggestion & Recommendation; Essay writing: Analytical and Argumentative

Unit III

Sounds of English: Stress, Intonation - Listening Comprehension (3 pieces – Women in Technology Panel discussion, India Questions Abdul Kalam, UPSC Topper Mock interview Akshat Jain) - Current News Awareness

Unit IV

Reports: Incident Report, Event Report

Situational Dialogue; Group Discussion (Opinion)

Unit V

Mini Project and Presentation

References:

1. Felixa Eskey. *Tech Talk*, University of Michigan. 2005
2. Michael Swan. *Practical English Usage*, Oxford University Press. 2005
3. Anderson, Paul. *Technical Communication: A Reader Centered Approach*, V Edition, Hercourt, 2003 .
4. Martinet, Thomson, *A Practical English Grammar*, IV Ed. OUP, 1986.
5. Raymond V. Lesikar and Marie E. Flatley. *Basic Business Communication*, Tata

McGraw Hill Pub. Co. New Delhi. 2005. Tenth Edition.

6. Thampi, G. Balamohan. *Meeting the World: Writings on Contemporary Issues*. Pearson, 2013.
7. Lynch, Tony. *Study Listening*. New Delhi: CUP, 2008.
8. Kenneth, Anderson, Tony Lynch, Joan Mac Lean. *Study Speaking*. New Delhi: CUP, 2008.
9. Marks, Jonathan. *English Pronunciation in Use*. New Delhi: CUP, 2007.
10. Syamala, V. *Effective English Communication for You (Functional Grammar, Oral and Written Communication)*: Emerald, 2002.
11. Sample Question Papers from Competitive Examinations
12. Women in Technology Panel discussion
    https://youtu.be/T44XdGH5s-8?si=A1cDVEt777FH7vFR
13. India Questions Abdul Kalam
    https://youtu.be/erg3CmVm6M4?si=WjP_SV1vy6FrsGHg
14. UPSC Topper Mock interview, Akshat Jain
    https://youtu.be/lsJBGvyiAHI?si=L-u6kTadzJmghHLI

24MAL111 **Malayalam II** **LTPC: 2 0 0 2**

Course objective:

- To develop independent reading skills and reading for appreciating literary works.
- To develop elaboration and modernization of the vocabulary of a language
- To enable the students to plan, draft, edit & present a piece of writing.

Course outcomes:

CO1: Develop the ability to read and critically appreciate a given text
CO2: Develop fluency in communication
CO3: Develop interest in blending of language and Indian Spirituality
CO4: To enable the learners to understand the grammatical structures of classes of words

Unit Topic

1 Memoirs-One of the Selecrtion from Chiudambara Smarana-Balachandran Chullikkadu-Critical analysis of his poetry)
2 Ancient Drama: Kerala Sakunthalam (Act 4), Kalidasan (Transilated by Attoor Krishna Pisharody).
3 Satire One of the Selection from Chemmanam Chacko,VKN Or Punathil Kunjabdulla-philosophical dimens of Satire
4 Part of an auto-biography/travelogue:
Valarnnu varunna oratmavu(from Kanneerum Kinavum)-VT Bhattathirippad
5 Error-freeMalayalam: 1.Language; 2.Clarity of expression; 3.Punctuation-Thettillatha Malayalam – Writing-a. Expansion of ideas

Text books/Reference:

1) Hasa Sahithyam Kuttikrishna Mararu

2) Sakunthalam-Attoor/Kuttikrishna Marar
3) Kalidasa Hridayam-K.P.Narayana Pisharady
4) VKN-K.P.Appan
5) N.V.Krishna Warriar & Modern Poetry studies
6) Kanneerum Kinavum –V.T. Bhattathirippad
7) Adukkalayil Ninnu Arangatheykku-V.T.Bhattathirippadu
8) Nalla Malayalam- C.V.Vasudeva Bhattathiri
9) Tettum Sariyum-Prof. Panmana Ramachandran Nair

24HIN111	HINDI II	2 0 0 2

Course Objective: The course will allow students to apply grammar in language structures, appreciate the literary compositions and provide them with a good command over translation techniques.

Course outcomes: By the end of the course the students will be able to:

1. Understand the postmodern trends of literature...
2. 2.Explore tradition and culture through literature.
3. Apply ethical and professional translation strategies.
4. Demonstrate linguistic competence in written communication.

UNIT 1

Hindi Laghu Upanyas **:Mamatha Kaliya- ' Doud'**

UNIT 2

Hindi Natak**:** Swadesh Deepak- "Kort Marshal"

UNIT 3.

Adhunik Hindi Kavya a.Jayashankar Prasad-(Lahar, Aah!Vedhana Mili Vidayi)., b.Suryakanth Tripathi „Nirala"- (Anamika -4)., c.Subadhra Kumari , Chouhan- (Swadesh Ke Prathi, Smruthiyam), d.Gajanan Madhav Muktibodh- (ek swapna Katha)

UNIT 4.

A)Sankshepan,

B) .Anuvad: Paribhasha,Prakar,AnuvadKeLakshan,AnuvadKiAvashyakata,Passage (Translation)

c)Paragraph writing

D)Technical writing

REFERENCE

1. Prayojan Mulak Hindi Ke Naye Ayam: Dr. Pandit Banne
2. Prayojan Mulak Hindi Ki Nayi Bhumika : Kailash Nath Pandey
3. Prayojan Mulak Hindi Ke Vividh Roop : Dr. Rajendra Mishra, Rakesh Sharma
4. "Adhunik Kavya Sangraha" Edited by . Dr. Urvashi Sharma (Printed and Published by Malik & Company, Jaipur)
5. Hindi Samay.com,/Hindikahani.com/exotic indiaart.com

24KAN111 Kannada II LTPC: 2 0 0 2

Objectives:

- To develop the standard of orthography and spelling system.
- To develop independent reading skills and reading for appreciating literary works.
- To develop elaboration and modernization of the vocabulary of a language.
- To enable the students to plan, draft, edit & present a piece of writing.

Course Outcome

CO1	Develop the ability to read and critically appreciate a given text
CO2	Develop pattern of communication as required for different professional context
CO3	Develop fluency in speaking the language

Course Contents

UNIT – 1

Prabandhagalu

- Thotadacheya Bhoota – Kuvempu
- Bantu Bannada Holi – G. S. Shivarudrappa

UNIT – 2

Poems

- Ni hinga nodabayda Nanna – Da. Ra. Bendre
- Huttarihaadu – Panje Mangesh Rao
- Tungabadre – K.S.Narasimhaswamy
- Nanna Janagalu – Dr.Siddhalingaya

UNIT – 3

Novel

- Jugari Cross – Poornachandra Tejaswi

UNIT – 4

- Suttole

- Kadata
- prakatane
- Arjigalu
- Aadesha patraa

UNIT- 5

- Varadigalu
- Sanshikpta Baravanige
- Prabandhagalu: vaadaatmaka haagu vishleshanatmaka

References:

1. Jugari Cross – Poornachandra Tejaswi – Pustaka Prakashana
2. Shatamaanada Lalitha Prabandha – Gurulinga Kaapase - Karnataka Sahitya Academy
3. N.Gopalkrishna Adiga – Kannada Vyakarana mattu Rachane – MCC Publications
4. Maadhari Patragalu – S.R.Siddharaju – Kannada Saahitya Parishattu
5. H.S.Krishnaswamy Iyangar – Adalitha Kannada – Chetana publication, Mysuru

24SAN111 SANSKRIT II LTPC: 2 0 0 2

Module I

Seven cases, Avyayas, sentence making with Avyayas, Sapthakakaras.

Module II

Kthavathu Prathyaya, Upasargas, Kthvatha, Thumunnantha, LyabanthaPrathyaya. Three Lakaras – brief introduction, Lot lakara

Module III

New words and sentences for the communication, Slokas, moral stories, Subhashithas, riddles (Selected from the Pravesha Book)

Module IV

Introduction to classical literature, classification of Kavyas, classification of Dramas - Important five Mahakavyas

Module V

Translation of paragraphs from Sanskrit to English and vice versa

Module VI

Chanakya Neeti chapter III (Part II), Bhagavad Geeta chapter 14 (Part II)

Essential Reading:

1, Praveshaha; Publisher :Samskritabharati, Aksharam, 8th cross, 2nd phase, girinagar, Bangalore -560 085
2, Sanskrit Reader I, II and III, R.S. Vadhyar and Sons, Kalpathi, Palakkad
3, PrakriyaBhashyam written and published by Fr. John Kunnappally
4, Sanskrit Primer by Edward Delavan Perry, published by Ginn and Company Boston
5, Sabdamanjari, R.S. Vadyar and Sons, Kalpathi, Palakkad
6, Namalinganusasanam by Amarasimha published by Travancore Sanskrit series
7, SubhashitaRatnaBhandakara by Kashinath Sharma, published by Nirnayasagarpress

24TAM111	TAMIL II	2 0 0 2

Course Objective: The course will allow students to understandthewriting competency in Tamil literature.

Course outcomes: By the end of the course the students will be able to:

1. Introduction to Tamil Folklore
2. Learning the nuances of Tamil spiritual literature
3. Exposure to the advanced aspects of Tamil grammar
4. Imbibing the spirit of language through familiarising with linguistics, translation and creative writing

அலகு 1

சிற்றிலக்கியங்கள்அறிமுகம்: கலிங்கத்துப்பரணி (பபோர்போடியது), முக்கூடற்பள்ளு 35. நோட்டுபுறவியல்: வரரவிலக்கணம், நோட்டுபுறப்போடல்கள், கரதகள், கரதப்போடல்கள், பழமமோழி, விடுகரதகள், கரலகள்.

Introduction to CiRRilakkiyam: Kalingaththupparani (Poor Padiyathu) - MukkdaRpallu 35. Folklore: Definition, Folksongs - Stories – kathaipPaadal - pazhamozhi - vidukathai - kalaikaL.

அலகு 2

பக்திஇலக்கியம்: ஆண்டோள்முழுவரலோறு, திருப்போரவ (1,2,3,4)

அலகு 3
மதோல்கோப்பியம்: மபோருளிலக்கணம் - மோல்லிலக்கணம்
அலகு 4
மமோழிமபயப்பு: மமோழிமபயப்புவரகைள்,
மமோழிமபயர்ப்பின்முக்கியதுவமும்பதரவயும், இயந்திரமமோழிமபயர்ப்பு,
மகோள்ரகைள், இலக்கியமமோழிமபயர்ப்பு. மமோழியியல்அறிமுகம்:
மமோழியும்மமோழியியலும், பயன்போடுமமோழியின்தன்ரமகள்
,மமோழியியல்துரறகள். பரடப்புஉருவோக்குதல் (கருத்துபரிமாற்றம் -
கவிரதஇலக்கியம்- அறிமுகம், விடுதரலக்குமுன்னும்பின்னும் - நாடகம் -
சிறுகதத).
Translation: Types of translation - Importance and need of translation - Machine translation - Principles - Literary translation.
Introduction to Linguistics: Language and Linguistics- Linguistics – Characteristics of applied language – Fields of Linguistics. Creation of creativity (Exchange of ideas - introduction to poetry literature, before and after liberation - drama - short story).

REFERENCES

மு.வரதரோன்“ தமிழ்இலக்கியவரலோறு”
ோஹித்யஅகமடமிபப்ளிபகஷன்ஸ் , 2012 மபோன்மணிமோறன்
“அபடோன்தமிழ்இலக்கணம் “அபடோன்பப்ளிஷிங்குரூப், வஞ்சியூர்,
திருவனந்தபுரம், 2007. http:/www.tamilvu.org/libirary/libindex.htm.
http:/www.gunathamizh.com/2013/07/blog0post_24.html நோ.வோனமோமரல,
“தமிழர்நோட்டுப்போடல்கள்” நியூமஞ்சுரிபுத்தகமவளியீட்டகம் 1964,2006
நோ.வோனமோமரல “பழங்கரதகளும், பழமமோழிகளும்
”நியூமஞ்சுரிபுத்தகமவளியீட்டகம், 1980,2008

SEMESTER 3

25CHY203 **Principles of Organic Chemistry** **3 1 0 4**

CO01 Apply stereochemistry principles for various chemical reactions
CO02 Analyze the conformation of acyclic and cyclic molecules and apply them towards the reactivity and selectivity
CO03 Elucidate mechanistic aspects of various types of substitution reactions in aliphatic and aromatic compounds and apply them for organic synthesis.
CO04 Explore various types of addition reactions and their mechanisms in unsaturated compounds including carbonyl compounds.
CO05 Apply elimination reactions for organic synthesis

Unit 1: Aromaticity [9 h]

Delocalised chemical bonding – 1,3-butadiene, frontier orbitals. Criteria for aromaticity – energy, structural and electronic criteria for aromaticity – relationship among them. Aromatic, antiaromatic and homoaromatic compounds. Aromaticity in annulenes, polycyclic and nonbenzenoid compounds, charged rings - aromatic cations and anions. Heteroaromatic systems.

Unit 2: Stereochemistry [9 h]

Optical and geometrical isomerism – Atropisomerism. Stereochemistry - symmetry and stereochemistry, chirality and symmetry, optical activity and chirality. Methods to determine configuration. Stereochemical descriptors, topicity relationships, molecules with more than one stereogenic centre. Asymmetric synthesis – methods of resolution, optical purity. Stereoselectivity, stereospecificity and regioselectivity.

Unit 3: Conformational Analysis and Linear Free Energy Relationship [12 h]

Conformational analysis - acyclic and cyclic systems – four, five and six-membered rings. Conformations of mono and di substituted of six membered rings. Conformational effects on the reactivity of acyclic and cyclic systems. Kinetically and thermodynamically favoured products. Chemoselectivity, regioselectivity, enantioselectivity, and stereoselectivity.

Hammond postulate, Curtin-Hammett principle, microscopic reversibility. Baldwin rules. Isotope effects, substituent effects, linear free energy relationship (LFER), Hammet plots, steric and polar effects – Taft parameters.

Unit 4: Substitution Reactions [15 h]

Aliphatic nucleophilic substitution - the S_N1, S_N2, borderline, S_Ni mechanisms and their stereochemistry. Factors affecting the rates of S_N1, S_N2 and S_Ni. Neighbouring group participation. Effect of substrate structure, nucleophile, leaving group and medium on reactivity. Ambident nucleophiles and substrates Substitution vs elimination reaction. Aromatic electrophilic and nucleophilic substitutions - mechanism – factors influencing, *ipso* substitution and directive effect.

Unit 5: Addition and Elimination Reactions [15 h]

Hydrogenation of alkene - syn and anti-additions. Electrophilic addition to alkenes - Markovnikov's Rule – HX, H_2O, H_2SO_4, halogen, oxymercuration, hydroboration oxidation. Oxidation of alkenes to diols. Conjugate addition to alkenes. Nucleophilic addition-Nucleophilic addition reaction to carbonyl group - reactivity of aldehydes and ketones -molecular orbitals explanation. Addition of oxygen, nitrogen, sulfur and carbon based nucleophiles to carbonyls. Reactions with ylides.

E1, E2, and E1cB reactions – mechanisms – factors influencing elimination - stereochemistry. Zaitsev and Hoffmann rule – dehydrohalogenation, dehydration of alcohols, quaternary ammonium salts. Pyrolytic elimination.

Recommended Reading

1. Solomons, T.G. and Fryhle, C.B., 2011. Organic chemistry. John Wiley & Sons.
2. Bruice, P.Y., 2017. Organic chemistry. Pearson.
3. Carey, F.A. and Sundberg, R.J., 2007. Advanced organic chemistry: part A: structure and mechanisms. Springer Science & Business Media.
4. March's Advanced Organic Chemistry: M. Smith and J. March, 6th edition, Wiley-Interscience
5. Clayden, J., Greeves, N. and Warren, S., 2012. Organic chemistry. Oxford university press.
6. Nasipuri, D., 2005. Stereochemistry of organic compounds: principles and applications. New Age International.

25CHY204 Equilibria, Dilute solutions, Surface and Photochemistry 3 1 0 4

CO Course Outcomes

CO01 Acquire a thorough understanding of the thermodynamics of equilibrium in chemical reactions

CO02 Represent, analyse and interpret the phase diagrams for different transitions and express the thermodynamics of the transformations

CO03 Understand the equilibrium properties of dilute solutions and its applications

CO04 Develop thorough knowledge on the properties, thermodynamics of surfaces and applying this for catalytic applications

CO05 Understand the consequence of light absorption by chemical systems and their applications

Unit 1: Chemical Equilibrium [7 h]

Law of mass action, equilibrium constant – relation between K_p, K_c and K_x. Thermodynamic treatment of the law of mass action – van't Hoff reaction isotherm. Temperature dependence of the equilibrium constant – van't Hoff's equation. Pressure dependence of the equilibrium constant K_p and K_c. Factors that change the state of equilibrium – Le Chatelier's principle and its application to chemical and physical equilibria.

Unit 2: Phase Equilibria [10 h]

Phase, components and degrees of freedom. Derivation of Gibbs phase rule. Application of phase rule to one component system. Reduced phase rule. Two component system - simple eutectic. Pattinson's

process. Phase diagram - steel, alloys, Fe-C system and zone refining. Thermal analysis and cooling curves - compound formation with congruent melting point - Zn–Mg and incongruent melting point – Na-K system. Continuous solid solutions of metals and solid solutions with minimum and maximum melting points.

Unit 3: Dilute Solutions [15 h]

Concept of activity and activity coefficients. Two component systems - completely miscible liquids – azeotropes, Duhem - Margules equation, partially miscible liquids - lower and upper CSTs - effect of impurities on CST. Three component system - completely immiscible and partially miscible liquids - triangular coordinates. Nernst distribution law – derivation and applications. Colligative properties – determination of molecular weight.

Unit 4: Surface Chemistry, Catalysis and Colloids [16 h]

Adsorption – physical and chemical - thermodynamics of adsorption, adsorption isotherms – Freundlich, Langmuir, and BET - positive, negative and electrostatic adsorption. Applications of adsorption. Catalysis - homogeneous catalysis – kinetics of acid–base catalysis and mechanism. Heterogeneous catalysis – kinetics – Langmuir-Hinshelwood mechanism, monolayer and multilayer adsorption. Enzyme catalysis - factors affecting enzyme-catalyzed reactions. Catalyst poisons. Catalysis in the chemical industry.

Colloidal state – properties, stability - zeta potential, isoelectric point. Protective colloids - Hofmeister series. Coagulation or flocculation - Hardy-Schulze law. Micelle and critical micelle concentration. Application of colloids.

Unit 5: Photochemistry [12 h]

Consequences of light absorption - Jablonski diagram. Laws of photochemistry - Beer-Lambert law, Grotthus-Draper law and Stark Einstein law. Quantum efficiency. Energy transfer in photochemical reactions – photosensitisation. Quenching - Stern-Volmer equation, Forster resonance energy transfer and Marcus theory. Photochemical reactions - kinetics, chemiluminescence and photoelectric cells.

Recommended Readings

1. Atkins, P., Atkins, P.W. and de Paula, J., 2014. Atkins' physical chemistry. Oxford university press.
2. Glasstone, S., 1951. Textbook of physical chemistry. Macmillan.
3. Birdi, K.S., 2009. Surface and colloid chemistry: principles and applications. CRC press.
4. Puri, S. and Sharma, R.L., 2004. Pathania, Principles of Physical Chemistry. Vishal Publishing Co

25CHY205 Organic Synthesis - I 3 1 0 4

CO1: Analyze the mechanisms involved in different types of organic processes

CO2: Evaluate the chemical and physical properties of oxygen and nitrogen containing organic compounds

CO3: Apply the knowledge of basic reaction mechanisms to synthesize wide range of important aromatic and aliphatic compounds including alcohols, phenol, ethers, etc.

CO4: Elucidate the structure and reactivity of various organic compounds containing carbonyl functional groups

CO5: Design synthesis of various common organic compounds.

Unit 1: Oxygen Functional Groups [12 h]

Carbonyl compounds - aldehydes and ketones - enolates. Active methylene compounds- synthesis and application of ethyl acetoacetate, diethyl malonate and cyanoaceto esters. Mono, di- and unsaturated carboxylic acids – preparation and reactions. Carboxylic acid derivatives – preparation and reaction of acid chlorides, anhydrides, amides, esters. Hemiacetal, hemiketal, acetal, orthoester, ether, epoxides - preparation and reactions.

Unit 2: Nitrogen Functional Groups [12 h]

Amino compounds – nomenclature and classification. Carbylamine reaction, diazotization – comparison of aliphatic and aromatic amines. Reductive amination of aldehydic and ketonic compounds. Amidine, azide, azo, diazoalkanes, cyanates, nitrile, nitrite, oxime, carbamate ester, nitro compounds, and diazonium salts – preparation and reactions.

Unit 3: C-C, C-N, and C-O/S bond formation [12 h]

C-C bond formation – aldol, Arndt-Eistert, Bardhan-Sengupta, Baker-Venkataraman, Barbier, Baylis-Hillman, Benzoin, Dieckmann, Friedel–Crafts, Michael, Perkin, Claisen, Robinson annulations, Vilsmeier, Wittig, Knoevenagel, and Ullmann Reactions. C-N bond formation – Mannich, Mitsunobu, Ritter, Gabriel, Ugi, Doebner, Buchwald-Hartwig, and Stork enamine reactions. Formation of azides and hydrazines. C-O and C-S bond formation –Fischer esterification, Williamson's ether synthesis, Barton, Prins, Darzen, Baeyer-Villiger, and Mitsunobu reactions.

Unit 4: Oxidation [12 h]

Alcohols to carbonyl compounds - chromium(VI) oxidants, dimethyl sulfoxide - Swern oxidation, manganese(IV) oxide, silver carbonate, hypervalent iodine(III) and (V) reagents, ceric ammonium nitrate (CAN), N-oxyl radical. Alkenes to epoxides by H_2O_2, hydroperoxides and peroxyacids. Prevost oxidation and Woodward modifications. Oxidative cleavage of 1,2-diols - periodic acid. Oxidation of allylic and benzylic C-H bonds - NBS, DDQ, chloranil-T, SeO_2, and TEMPO. Oppenauer and Corey-Kim oxidation.

Unit 5: Reduction [12 h]

Catalytic hydrogenation - homogeneous and heterogeneous catalytic reductions. Dissolving metal reductions. Non-metallic reductions - Wolff-Kishner, diimide reductions, and Hantzsch ester. Metal hydride reductions - Nucleophilic metal hydrides, Sodium cyano borohydride, Li and Na borohydrides, $LiAlH_4$, DIBAL-H and Red-Al. Electrophilic metal hydrides - BH_3 and AlH_3. Hydrogenolysis - use of tri-n-butyl tin hydride.

Recommended Readings

1. Carey, F.A. and Sundberg, R.J., 2007. Advanced organic chemistry: part B: reaction and synthesis. Springer Science & Business Media.

2. Smith, M.B., 2020. March's advanced organic chemistry: reactions, mechanisms, and structure. John Wiley & Sons.
3. Li, J.J. and Corey, E.J., 2007. Name Reactions of Functional Group Transformations (Vol. 1). John Wiley & Sons.
4. Clayden, J., Greeves, N. and Warren, S., 2012. Organic chemistry. Oxford university press.
5. Norman, R. and Coxon, J.M., 2017. Principles of organic synthesis. Routledge.
6. Carey, F.A. and Sundberg, R.J., 2007. Advanced organic chemistry: part A: structure and mechanisms. Springer Science & Business Media.
7. Lin, G.Q., Li, Y.M. and Chan, A.S., 2001. Principles and applications of asymmetric synthesis. John Wiley & Sons.

25CHY281 Chemistry Lab - II 0 0 2 1

CO Course Outcomes

CO01 Develop thorough knowledge and experimental skills in the determination of different organic compounds

CO02 Develop skills in the determination of physical constants based on fundamental principles of physical chemistry

CO03 Acquire knowledge in the design of experiments based on fundamental concepts in chemistry

Part A

1. Estimation of equivalent weight of an acid
2. Estimation of glucose
3. Estimation of phenol and aniline
4. Estimation of acetone
5. Estimation of acid value of an oil
6. Estimation of iodine value and sap value of an oil
7. Estimation of Nitrogen – Kjeldahl method
8. Estimation of formaldehyde
9. Estimation of ester

Part B

1. Construction of isotherms for acetic acid adsorption on activated charcoal
2. Determination of critical solution temperature for the phenol water system and effect of ionic electrolytes
3. Determination of molecular weight by Rast’s method-colligative properties
4. Determination of partition coefficient of iodine in CCl4-water mixture
5. Determination of average molecular weight of a polymer by viscosity measurements
6. Determination of calorific value of fuels by bomb calorimetry
7. Determination of Arrhenius parameters for ester hydrolysis reaction

8. Determination of order of ion exchange reactions
9. Polarimetric determination of the rate of inversion of the sugar

Recommended Readings

1. Mann F. G., and Saunders, B. C.2009. 'Practical Organic Chemistry' 4th edition, Pearson Education.
2. Ahluwalia V. K. and Dhingra. S. 2000. 'Comprehensive Practical Organic Chemistry' Universities Press.
3. Furnis, B. S., Hannaford, A. J., Smith P. W. G. and Tatchell, T. R.1989. 'Vogel's Textbook of Practical Organic Chemistry', ELBS/Longman.
4. Vogel, A. I. 1985. 'A Textbook of Qualitative Analyses', 4th edition, Longmans publications.
5. Pass G., Sutcliffe, H. 1974. 'Practical Inorganic Chemistry', 2nd edition, Chapman & Hill,
6. Parshall, G. W. 1974. 'Inorganic Synthesis', Vol. 15, Tata McGraw-Hill Education.
7. Das. R.C. and Behara. B., 1983. 'Experiments in Physical Chemistry', Tata McGraw-Hill.
8. Findly. A., 1972.' Practical Physical Chemistry', 9th edition, Wiley.
9. Yadav, J.B.2010. 'Advanced Practical Physical Chemistry', Krishna Prakashan Media, 29th edition.
10. Shoemaker, D.P., Garland, C.W. and Steinfeld, J.I., 2018. *Experiments in physical chemistry*. McGraw-Hill.
11. Malati, M.A., 1999. *Experimental inorganic/physical chemistry: an investigative, integrated approach to practical project work*. Elsevier.
12. Atkins, P., Atkins, P.W. and de Paula, J., 2014. *Atkins' physical chemistry*. Oxford university press.

25CSA281 Programming Lab - I 0 0 2 1

1. 2D and 3D plotting of functions (Scilab, Python)
2. Curve fitting
3. Least square fit Goodness of fit& standard constant
4. Solution of Linear system of equations: Gauss elimination
5. Solution of Linear system of equations: Gauss Seidal method
6. Solution of ODE First Order Differential equation:
7. Solution of ODE second order Differential equation

List of Experiments

1. Ohms law to calculate R,
2. Hooke's law to calculate spring constant
3. Solution of mesh equations of electric circuits
4. Solution of coupled spring mass systems
5. Radioactive decay
6. Current in RC, LC circuits with DC source

7. Newtons law of cooling
8. Classical equations of motion
9. Current in RC, LC circuits with DC source
10. Newtons law of cooling
11. Classical equations of motion
12. Harmonic oscillator •
13. Damped Harmonic oscillator- Overdamped- Critical damped
14. Forced Harmonic oscillator

Recommended Readings

8. A Survey of Computational Physics- Introductory Computational Science" Rubin H. Landau, Manuel José Páez, Cristian C. Bordeianu, 2008, Princeton university press.
9. Introduction to Numerical programming: Steven A. Gottlieb and Rubin H. Landau, CRC Press.

25CSA202 Digital and Technological Solutions 1 0 2 2

Course objectives

This course aims to provide students with a comprehensive understanding of computer science and digital technology. They will learn the usage of ICT services, digital India initiatives and emerging technologies.

Course Outcomes

CO1	Describe the significance of digital technology	L1
CO2	Find the solution of a computational problem by tracing flowcharts	L2
CO3	Use ICT services	L2
CO4	Explain emerging Technologies – AI , Block Chain, Cloud computing	L1
CO5	Explain Digital India Initiatives	L1

Unit I (2 weeks)
Evolution and generations of Computers. Classification of computers. Role & Significance Of Digital Technology. Software And Its Types. Overview of computer architecture, Operating Systems, DBMS, Microsoft office tools

Unit II (4 weeks)
Computational Thinking, Four corner stones of computational thinking, Flowcharts using Flowgorithm tool. Create and trace flowcharts for simple computational problems – Even or odd, Largest among three numbers, Searching and sorting

Unit III (4 weeks)

Computer Networks, Internet: Concepts & Applications, WWW, Email, Social media, Platforms for digital collaboration, Tools and Platforms for digital learning, Cybersecurity and Ethics in digital communication

Unit IV (2 weeks)
Overview of AI, Blockchain, Cloud computing, IoT .

Unit V (3 weeks)
Digital India & E-governance: Initiatives, Digital Financial Tools: Unified Payment Interface, Aadhar Enabled Payment System, USSD, Credit / Debit Cards, E-wallets,

Textbook

1. *Fundamentals of computers, Balaguruswamy, Tata McGraw Hill, 2009*
2. *Introduction to computers, Peter Norton, Tata McGraw Hill, 2017*

Computational Thinking A beginner's guide to problem solving and programming, Karl Beecher, BCS Learning & Development Ltd 2017

SEMESTER 4

25CHY213 Chemistry of Main Group Elements 3 1 0 4

CO01 Potential to describe the coordination and organometallic compounds' properties, applications, and bonding patterns of alkali and alkaline earth metals and group V, VI, VII, and VIII elements

CO02 Ability to explain the bonding types and molecular structures in advanced chemistry, specifically for carbon, nitrogen, oxygen, boron, and phosphorus compounds.

CO03 Ability to comprehend the chemistry of inorganic polymers and their commercial applications

Unit 1:Alkali and Alkaline Earth Metals [12 h]

Synthesis and structure of hydrides, amides, alkoxides and coordination compounds of alkali and alkaline earth metals. Crown ethers and cryptands as complexing agents for alkali metal ions. Alkali and alkaline earth metals in liquid ammonia and other solvents. Unusual anions. Organometallic chemistry of alkali and alkaline earth metals - synthesis, structures, fluxionality and reactivity.

Unit 2: Triels and Crystallogens [16 h]

Synthesis, structure, bonding and reactivity of boron hydrides. STYX numbers. Wade's rule - closo, nido and arachno structure of boranes, carboranes and metallocene carboranes. Borides. Compounds of triels with nitrogen and halogens. Allotropic forms of carbon - fullerenes, CNTs and graphenes. Carbides. Hypervalent carbon compounds. Compounds of crystallogens with nitrogen and halogens. Element to element multiple bond compounds Organometallic chemistry of boron, aluminium, gallium, indium, thallium, silicon, germanium and tin – syntheses, structure and application.

Unit 3: Pnictogen and Chalcogens [12 h]

Preparation and properties of compounds of pnictogen and chalcogens with nitrogen, halogen and other important compounds. Element to element multiple bond compounds – homonuclear and heteronuclear compounds, and dπ-pπ bonding. Organometallic compounds of phosphorous, arsenic, antimony, bismuth, sulphur, selenium and tellurium – syntheses and properties.

Unit 4: Halogen and Noble Gases [8 h]

Application of hydrogen halides as nonaquous solvents. Halides of transition metals. Oxohalogen fluorides. Polyhalide anions and halogen cations. Apicophilicity. Chemistry of astatine. Synthesis and structure of fluorides, fluoroanions, fluorocation, oxo compounds of xenon and other elements of noble gases. Clathrate compounds.

Unit 5:Inorganic Chains, Rings, Cages and Clusters [12 h]

Introduction and nomenclature of inorganic polymers, chains, rings, cages and clusters. Borazine, boron cage compounds, sulphur-nitrogen compounds, polymeric sulphur nitride, silicates, polysilicone, fullerenes and polymers with P-N bonds. Isopoly anions, heteropoly anions, Keggin and Dawson polyoxometallates, metal clusters. Main group element clusters and main group element-transition metal mixed clusters.

Recommended Readings

1. Cotton, F.A., Wilkinson, G., Murillo, C.A. and Bochmann, M., 1999. Advanced inorganic chemistry. John Wiley and Sons, Inc.
2. Greenwood, N.N. and Earnshaw, A., 2012. Chemistry of the Elements. Elsevier.
3. González-Moraga, G., 2013. Cluster chemistry: introduction to the chemistry of transition metal and main group element molecular clusters. Springer Science & Business Media.
4. Akiba, K.Y., 2011. Organo Main Group Chemistry. John Wiley & Sons.
5. Huheey, J.E., Keiter, E.A., Keiter, R.L. and Medhi, O.K., 2006. Inorganic chemistry: principles of structure and reactivity. Pearson Education India.
6. Housecroft, C.E. and Sharpe, A.G., 2008. Inorganic chemistry (Vol. 1). Pearson Education.
7. Purcell, K.F. and Kotz, J.C., 2010. Inorganic chemistry. Holt-Saunders International Editions.

25CHY214 Organic Synthesis - II 3 1 0 4

CO1: Design the synthesis of complex organic molecules using critical reagents

CO2: Apply photochemical organic synthesis for a greener approach

CO3: Analyse the mechanism of the light-induced organic reactions and predict the nature of the product

CO4: Scrutinize the synthesis of asymmetric organic compound

CO5: Create suitable reaction pathways to achieve specificity and selectivity in the products.

Unit 1: Organometallic Reagents and Catalysts [14 h]

Application of organometallic compounds of lithium, magnesium, boron, silicon and tin in organic synthesis. Applications of organo platinum-group metals, organonickel, organocobalt, organocopper, organozinc, organocadmium and organomercury in organic synthesis.

Unit 2: Synthetic Strategies - I: Functional Group Interconversions [14 h]

Functional group interconversions, the importance of the order of events in organic synthesis, chemoselectivity, regioselectivity, and Umpolung concept. The concept of protection and deprotection of functional groups in synthesis. Protection of amino, hydroxy, diol, carbonyl and, double and triple bonds.

Unit 3: Synthetic Strategies – II: Retro Synthesis [9 h]

Disconnection Approach - synthons and synthetic equivalents, donor and acceptor synthons, disconnection, alternating polarity disconnection and steps in planning the synthesis. One and two groups C-X and C-C disconnections. Control of relative stereochemistry and enatioselectivity in carbonyl condensations. 1-5 disfunctionalised compounds.

Unit 4: Rearrangement and Transformation Reactions [14 h]

Classification of rearrangements. General mechanistic consideration, nature of migration, migratory aptitude, stereochemical aspects and memory effects in rearrangements. Rearrangement to electron deficient carbon - pinacol-pinacolone, Wagner-Meerwein, benzillic acid, Wolf, Rupe and Demjanov rearrangements. Rearrangement to electron deficient nitrogen - Hofman, Curtius, Schmidt, Lossen and Beckmann rearrangements. Rearrangement to electron deficient oxygen - Baeyer-Villiger rearrangement. Rearrangement to electron rich carbon - Fovorskii, Wittig, Neber and Stevens rearrangements. Aromatic rearrangement - Fries, Claisen and benzidine rearrangements.

Unit 5: Asymmetric Synthesis [9 h]

Principles and applications of asymmetric synthesis. Stereoselectivity in cyclic compounds, enantio-selectivity, diastereo-selectivity, enatiomeric and diastereomeric excess, stereoselective aldol reactions. Cram's rule, Felkin Anh rule and Cram's chelate model. Asymmetric synthesis - use of chiral auxiliaries, chiral reagents and catalysts. Asymmetric hydrogenation, epoxidation and dihydroxylation.

Recommended Readings

1. Warren, S., 1991. Designing organic syntheses: a programmed introduction to the synthon approach. John Wiley & Sons.
2. Li, J.J. and Corey, E.J., 2007. Name Reactions of Functional Group Transformations (Vol. 1). John Wiley & Sons.
3. Norman, R.O.C., and Coxon, J.M., 2014. Principles of organic synthesis. CRC press,
4. Gawley, R.E. and Aubé, J., 2012. Principles of asymmetric synthesis. Elsevier.
5. Carey, F.A. and Sundberg, R.J., 2007. Advanced organic chemistry: part B: reaction and synthesis. Springer Science & Business Media.
6. Li, J.J., 2020. Name reactions: a collection of detailed mechanisms and synthetic applications. Springer Science & Business Media.
7. Rojas, C.M., 2015. Molecular Rearrangements in Organic Synthesis. John Wiley & Sons.

25CHY215 Quantum Chemistry 2 1 0 3

CO1: Understand the Foundations of Quantum Mechanics
CO2: Apply the Schrödinger Equation to Simple Systems
CO3: Utilize Approximate Methods in Quantum Mechanics
CO4: Analyze Angular Momentum and Electron Spin in Quantum Mechanics
CO5: Describe Quantum Mechanical Approaches to Chemical Bonding

Unit 1: Quantum Chemistry – Introduction [6 h]

Mechanics as a means for study of systemic characteristics. Limitations of classical mechanics while dealing with quantum entities - black body radiation, UV-catastrophe. Quantization of energy, dual behaviour of quantum entities, photoelectric effect, principle of uncertainty. Postulates of quantum mechanics - postulate I – wave functions, postulate II - operators in quantum mechanics, operator algebra, postulate III – eigen values, eigen value equations, postulate IV – expectation value, postulate V – time dependent and time independent Schrodinger equation.

Unit 2: Applying Schrodinger Equation to Various General Systems [12 h]

Translational motion of a quantum entity - particle in a box, quantum mechanical tunneling. Vibrational motion - harmonic oscillator. Rotational motion - rigid rotator, particle on a ring and particle on a sphere. Basic ideas on angular momentum.

Unit 3: Variation and Perturbation Methods [10 h]

One electron atomic system - hydrogen atom – wave function, orbitals. Multielectron atomic systems - the variation method – variation theorem, extension of the variation method, determinants, simultaneous linear equations and linear variation functions. Perturbation theory- nondegenerate perturbation theory, perturbation treatment of helium atom ground state, perturbation theory for a degenerate energy level, perturbation treatment of first excited states of helium. Time dependent perturbation theory - interaction of radiation with matter.

Unit 4: Angular Momentum and Electron spin [7 h]

Angular momentum - operators, ladder operators, orbital and spin angular momenta, angular momentum in many electron atoms. Atomic states, term symbols, splitting of term levels into atomic levels, spin-orbit interaction. Electron spin – eigen values and eigen functions of spin operator - matrix methods - spin-orbitals. Pauli principle - antisymmetric wave function.

Unit 5: Chemical Bonding - Quantum Mechanical Approach [10 h]

Hydrogen molecule ion and hydrogen molecule - molecular orbital and valence bond theory - homo and hetero nuclear diatomic molecules. The concept of directed valences and hybridization. Quantum mechanics in band theory of metallic solids. The virial theorem and chemical bonding.

Recommended Readings

1. Levin I.N., 2008. Quantum Chemistry 6th Edition, Prentice-Hall.
2. McQuarrie, D.A., 2008. Quantum chemistry. University Science Books.

3. Atkins, P.W. and Friedman, R.S., 2011. Molecular quantum mechanics. Oxford university press.
4. Prasad, R.K., 2019. Quantum chemistry. New Age International.
5. Szabo, A. and Ostlund, N.S., 2012. Modern quantum chemistry: introduction to advanced electronic structure theory. Courier Corporation.
6. Piela, L., 2013. Ideas of quantum chemistry. Elsevier.
7. Chandra, A.K., 1994. Introductory quantum chemistry. Tata McGraw-Hill Education.

25CHY282 Inorganic Chemistry Lab 0 0 6 2

After completion of the course students will be able to
CO01 Identify the anions present in the given mixture.
CO02 Eliminate the interfering anions present in the given mixture.
CO03 Analyse the cations present in the given mixture and separate them using selective precipitating agents.
CO04 Apply the principles of physical chemistry for precipitation, separation, and confirmation of cations and anions present in the mixture.

(Inorganic Semimicro Qualitative Analysis Lab)

Phase I: Simple salt analysis

Phase II: Two cation and two anion mixture

Phase III: Four cation analysis

Recommended Readings

1. Svehla, G., 2012. Vogel's qualitative inorganic analysis, 7/e. Pearson Education India.

25CHY283 Organic Chemistry Lab 0 0 6 2

Separation and analysis of binary mixtures of organic compounds

Separation, preliminary investigations, determinations of saturation/ unsaturation, detection of special elements by Lassaigne's test.

Functional group identification, derivative preparation, determination of melting points of the derivatives. Calculation of Rf values from thin layer chromatography (TLC) for the following mixtures

(a) Acid and hydrocarbon

(b) Phenol and Aldehyde

(c) Phenol and acid

(d) Phenol and amine

(e) Acid and ester

(f) Halo compound and aldehyde

(g) Acid and Aldehyde

(h) Amine and aldehyde

(i) Amine and ketone

(j) Alcohol and hydrocarbon

Recommended Readings

1. Smith, P.W.G., Hannaford, A.J., Furnis B.S. and Tatchell, A.R. 1989. Vogel's Textbook of Practical Organic Chemistry", ELBS/Longman.
2. Shriner, R. L., Hermann, C. K. F, Morrill, T. C., Curtin, D. Y., Fuson, R.C. 2003. Systematic Identification of Organic Compounds. John Wiley & Sons.
3. Mann and Saunders 2009. Practical Organic Chemistry. Pearson edition, 2009.

25CHY200 Scientific Writing and Technical Skills 2 1 0 3

Course Outcome:

On successful completion, the students will be able to
CO1: Identify a relevant potential source of research funding and develop a grant proposal to a professional standard
CO2: Demonstrate advanced skills in scientific writing and presentation
CO3: Perform background research and synthesize existing scientific literature
CO4: Critically review the work of your peers and analyze the ethics

Unit 1: Know the language (Basic English course)
Choosing the right word, using a dictionary and thesaurus, basic elements of a sentence, clauses, true sentences, tenses, active and passive verbs, punctuation and parallelism, Paragraphs, logic, and organization. Organizational strategies, art of précis
writing

Unit 2: Understanding the type of writings
Technical Writing - Various forms of scientific writing - theses, technical papers, reviews, manuals, etc.; Various parts of thesis and research communications (title page, authorship contents page, preface, introduction, review of literature, material, and methods, experimental results, and discussion)

Unit 3: Groundwork for effective scientific writing
Using web-based search engines, authenticating the information, editing in MS Office, style analysis programs, data entry and working knowledge of Excel, creating tables, figures, graphs, photographs and other documentary illustrations, explanatory artwork, An introductory idea about use of abode, photoshop and coral-making PowerPoint presentation, making and refining presentations using advanced presentation features, making a poster, using a library, indexing systems available for various science streams, e-resources, e-journals.

Unit 3 Start Writing (1)
Overview of science writing, how scientific writing is different from general writing, knowing your audience, writing for the general public, science reporting, Science news, explanatory writing, lengthy magazine articles, popular articles, and popular lectures.
Reading material: Popular science magazine articles. How to arrange references of a synopsis/thesis/article/dissertation, Writing of abstracts, summaries, etc.; use of abbreviations in the thesis.

Unit 4 Start Writing (2)
Writing for the scientific community, types of paper (short communication, original research article, review), the various components for each type, and the content of each component (title, author affiliation, abstract, keywords, introduction, material and methods, results and discussion, conclusion, references and bibliography, citation. Ethics in writing, plagiarism, plagiarism checker online. Publishing work: selection of journal, impact factors, h index,
following author guidelines, online submission, proofreading of a manuscript, understanding the symbols, reviewing of a manuscript, making corrections, and answering reviewers' query
galley proofreading.

Unit 5 Start Writing (3)
Writing research grant proposals, Book reviews, writing mini-profiles of prominent scientists, letters to editors, opinion writing, interview of a scientist, career in scientific writing

Unit 6 Presentation
Participation in group discussion: Facing an interview; presentation of scientific papers. Process of proofreading a research manuscript; the process of reviewing. Important journals, How to present a research paper/research work in a conference/seminar/workshop, How to defend synopsis/thesis

SEMESTER 5

25CHY303 Coordination Chemistry 3 1 0 4

Course Outcome

CO01: Apply the various theories of coordinate bonding to predict the geometry and properties of complexes as well as their stereochemistry.

CO02: Interpretation of electronic spectra of transition and inner transition metal complexes through various theories.

CO03: Improve their analytical and critical thinking skills by studying the various reaction mechanisms.

CO04: Acquire the knowledge to identify the magnetic properties of transition and inner transition metal complexes, and the latest electrochemistry and medical applications advancements.

Unit 1: Theories and Concepts on *d*-block Coordination Compounds. [15 h]

Werner's coordination theory, valence bond theory (VBT), crystal field theory (CFT) – CFSE - effects of CFSE, types of ligands. Spectrochemical series, spectral and magnetic properties, and nephelauxetic effect. Crystal field splitting - O_h, T_d, square planar, square pyramidal and trigonal pyramid geometries, factors affecting the magnitude of CFSE, isomerism in coordination complexes, Jahn-Teller (JT) distortion - manifestation on spectral properties. Limitations of CFT. Molecular orbital theory and ligand field theory.

Unit 2: Spectral and Magnetic Properties [15 h]

Russell-Saunders coupling schemes, term symbols for various d^n ions, Orgel diagrams for d^n systems, ligand field parameters, *Dq*, Racah parameter *B* and nephelauxetic constant. Tanabe-Sugano diagrams - applications. Charge-transfer transitions – MLCT and LMCT. Selection rules - spin-orbit and vibronic coupling effects. Spectral behaviour of *f*-block coordination complexes. Magnetic properties of coordination complexes - magnetic susceptibility - the contribution of spin-orbit coupling on μ_{eff}, types of magnetic behaviour - para, ferro, anti-ferro and ferri-magnetic systems. Curie and Curie-Weiss laws. Guoy, Faraday and SQUID methods. Kotani plots - effects of temperature on magnetic behaviour, multinuclear homo- and heterometallic 3*d, 4d and 5d* systems and mixed 3*d*-4*f* systems.

Unit 3: Reaction Mechanism [13 h]

Complex equilibrium - formation constants, factors affecting stability, stability constants. Mechanisms of ligand displacement and addition reactions, *cis*- and *trans*-effect and substitution reactions. Kinetic and thermodynamic consequences on reaction pathways. Mechanism - dissociation, interchange, association and conjugate base. Stereochemical aspects. Isomerisation of chelate rings, sigma and pi bonding effects. Oxidation-reduction reactions, inner and outer sphere electron transfer reactions.

Unit 4: Complexes of Inner Transition Elements [8 h]

Oxidation states, shapes of *f*-orbitals (4*f* and 5*f*), nature of bonding of *f*-orbitals with ligands, ligand preferences, coordination numbers and the geometry of the complexes. Influence of lanthanide and

actinide contraction in their coordination behaviour. Various types of coordination compounds of lanthanides and actinides.

Unit 5: Application of Coordination Compounds [9 h]

Medicinal applications - sodium nitroprusside complex for hypertension treatment. Cancer therapy – platinum and palladium anticancer agents, nonplatinum anticancer agents – mechanism of action. Vanadium compounds - mechanism of action. Electrochemical application - mechanism of an electrochemical process involving labile complexes, electrochemical process in a real system – copper cyanide and gold cyanide system, electro reduction of tin(II) and zinc(II) complexes. Electrochemical deposition of alloys.

Recommended Readings

1. Cotton, F.A., Wilkinson, G., Murillo, C.A. and Bochmann, M., 1999. Advanced inorganic chemistry. John Wiley and Sons, Inc.
2. Huheey, J.E., Keiter, E.A., Keiter, R.L. and Medhi, O.K., 2006. Inorganic chemistry: principles of structure and reactivity. Pearson Education India.
3. Lee, J.D., 2008. Concise inorganic chemistry. John Wiley & Sons.
4. Douglas, B.E., McDaniel D. and Alexander J. 2000. Concepts and models of inorganic chemistry. Wiley.
5. Atkins, P. and Overton, T., 2010. Shriver and Atkins' inorganic chemistry. Oxford University Press, USA.
6. J. E. House, “Inorganic Chemistry”, Academic Press, 2008.
7. Gopalan, R., 2001. Concise coordination chemistry. Vikas publishing house.
8. Jones, C.J. and Thornback, J.R., 2007. Medicinal applications of coordination chemistry. Royal Society of Chemistry.
9. Day, M.C. and Selbin, J., 1969. Theoretical inorganic chemistry.

25CHY304 Electrochemistry 3 1 0 4

CO Course Outcomes

CO01 Apply the first principles of chemistry to understand the properties of electrolytes and its applications

CO02 Understand the fundamentals of thermodynamics of electrode-electrolyte interface and their applications

CO03 Achieve comprehensive knowledge of the kinetics and quantitative aspects of electrochemical reactions through numerical problems

CO04 Apply electroanalytical techniques for optimizing experimental conditions for electrochemical reaction

CO05 Apply the electrochemical principles for the functioning and fabrication of industrial batteries and fuel cells

Unit 1: Quantitative Electrochemistry and Ionics [12 h]
Quantitative electrochemistry - review of Faraday's laws. Conductivity of electrolytes, Kohlrausch law, solubility product and salt hydrolysis. Debye-Huckel-Onsager equation – Debye-Huckel limiting law and its testing and improvement – conductometric titrations. Aqueous and non-aqueous electrolytes. Mass transfer in electrolytes – convection, diffusion and migration, general mass transfer equation - Nernst-Planck equation effect of supporting electrolytes, microscopic view of diffusion, Ficks law, boundary conditions.

Unit 2: Electrified Interfaces [10 h]
Electrochemical cells - cell resistance, standard electrode potentials, reversibility, calculation of emf – variation of potential with concentration, pressure and temperature. Interfacial region – electrical double layers and their structure. Polarizable and nonpolarizable electrodes. Eletrochemical potentials – properties – applications. Liquid junction potential – calculation – minimisation. Applications of potential measurements, reference electrodes, ion-selective electrodes, potentiometry, pH metry.

Unit 3: Kinetics of Electrochemical Reactions [14 h]
Transition state theory, essentials of electrode reactions, Butler-Volmer model, one step-one electron processes, transfer coefficient, exchange current, current over potential equation, Tafel plots, effects of mass transfer, multistep mechanisms, quasi reversible and irreversible processes, microscopic theories of charge transfer- Marcus model, distribution of energy states model, tunnelling and extended charge transfer. Faradaic and nonfaradaic processes, electrode reactions with coupled homogeneous chemical reactions. Theory for voltametric and chronopotentiometric methods.

Unit 4: Electroanalytical Techniques [10 h]
Potential sweep methods – linear sweep voltammetry and cyclic voltammetry - reversible, quasi-reversible and irreversible systems. Potential step methods – chronoamperometry, polarography-DME-Ilkovic equation, pulse voltammetry – normal and differential pulse. Electrochemical impedance spectroscopy – Bode and Nyquist plots.

Unit 5: Electrochemical Energy Storage Devices and Processes [14 h]
Electrochemical energy storage, principle of working of supercapacitors and batteries. Primary batteries, metal-air and lithium primary batteries. Secondary batteries - lead acid, lithium-ion and lithium polymer batteries. Fuel cells - PEMFC, direct methanol fuel cells. Industrial cathodic processes - electrodeposition of copper, nickel, zinc and chromium over mild steel. Industrial anodic processes - anodising of aluminium, electropolishing –electrochemical machining. Electroless deposition.

Recommended Readings
1. Allen, J. and Bard, R.L., 2000. Faulkner. Electrochemical Methods: Fundamentals and Applications, John Wiley and Sons. Inc. New York.
2. Bockris, J.O.M. and Reddy, A.K., 1998. Ion-solvent interactions. Modern Electrochemistry 1: Ionics, Springer.
3. Bockris, J.O.M., Reddy, A.K. and Gamboa-Aldeco, M., 2000. Electrodics. Modern Electrochemistry 2A: Fundamentals of Electrodics, 2nd Edition, Springer.
4. Pletcher, D. and Walsh, F.C., 1990. Industrial electrochemistry. Springer Science & Business Media.

5. Beard, K.W., 2019. Linden's handbook of batteries. McGraw-Hill Education.
6. Brenner, A., 2013. Electrodeposition of alloys: principles and practice. Elsevier

25CHY305 Molecular Symmetry and Group Theory 2 1 0 3

CO1: Understand the fundamental concepts of molecular symmetry and point groups

CO2: Construct and interpret character tables for molecular point groups

CO3: Apply the concepts of group theory to vibrational and electronic spectroscopy

CO4: Apply the concepts of group theory to Chemical Bonding

CO5: Understand the symmetry operations in the solid state and crystallographic point groups

Unit 1: Introduction to Molecular Point Groups [11 h]

Definition of a mathematical group. Symmetry in molecules- elements of symmetry, matrix representation of symmetry operations. Molecular point groups- abelian group, cyclic group, symmetry operations as group elements, similarity transformation and classes, group multiplication table, symmetry classification of molecules into pointgroups (Schoenflies symbol).

Unit 2: Construction and Interpretation of Character Tables [8 h]

Reducible and irreducible representations. Great Orthogonality Theorem and its consequences. Character tables-reduction formula, construction of character tables for point groups with order ≤6, interpretation of character tables.

Unit 3: Applications of Group theory - I (vibrational and electronic spectroscopy) [12 h]

Infrared and Raman activity of molecular vibrations in H_2O, N_2F_2, BF_3, AB_4 type molecules (Td and D_4h) and AB_6 type (Oh) of molecules, selection rules. Group theory to explain electronic structure of free atoms and ions- splitting of terms in a chemical environment, construction of energy level diagrams, estimations of orbital energies, selection rules and polarizations, double groups.

Unit 4: Applications of Group theory-II (Chemical bonding - Hybridization and Molecular Orbital Formation) [10 h]

Group theory to explain hybridization - wave functions as bases for irreducible representations, construction of hybrid orbitals for AB_3 (planar), AB_4 (Td), AB_5 (D_{3h}) and AB_6 (O_h) type of molecules. Symmetry adapted linear combinations- projection operators, application of projection operators to pi-bonding in ethylene, cyclopropenyl systems and benzene.

Unit 5: Symmetry in Solid State [4 h]

Symmetry elements and operations in solid state – proper axis of rotation, mirror planes of symmetry, roto- reflection and roto-inversion axes of symmetry, screw axes of symmetry, glide planes. A brief introduction to the crystallographic point groups and space groups.

Recommended Readings

1. Cotton, F.A., 2008. Chemical applications of group theory. John Wiley & Sons.
2. Carter, R.L., 1998. Molecular symmetry and group theory (p. 201). New York: Wiley.

3. Walton, D.P.H., 1998. Beginning group theory for chemistry. Oxford University Press.
4. Ramakrishnan V., Gopinathan M S, 2013, 'Group Theory in Chemistry (2nd reprint edition), Vishal Publications.
5. Salahuddin Kunju A, Krishnan G, 2015, Group theory and its application in chemistry (second edition), PHI Learning private LTD.

25CHY306 Analytical Chemistry 3 1 0 4

Course Outcome

CO1: Evaluate sensitivity, sources of interference, errors, and apply analytical data in terms of statistics.
CO2: Analyze chemical compounds by contemporary separation methods and appropriate selection of instruments
CO3: Explore the principle and working of the range of instrumental methods in analytical chemistry
CO4: Investigate solution behavior using electrochemical methods including potentiometry, conductometry, ion-selective, and cyclic voltammetric techniques.
CO5: Apply different microscopic methods and XRD technique in the analysis of materials

Unit 1: Errors, Statistics, and Sampling [10 h]

Theoretical principles of qualitative and quantitative analysis. Types of analytical methods - importance of analytical methods in qualitative and quantitative analysis - chemical and instrumental methods - advantages and limitations. Data analysis – average deviation, standard deviation, confidence limits, comparison of results - t-test and f-test, rejection of results, calibration curves, and correlation coefficient. Significant figures. Sampling - procedures and statistics.

Unit 2: **Aqueous and Solid Phase Extraction** [10 h]

Liquid-liquid extraction – theory and selection of solvents. Distillation - introduction, types of distillation, and applications. Solid phase extraction (SPE) – types, formats and apparatus, method of operation, solvent selection, factors affecting SPE, automation, and on-line SPE. Supercritical fluid extraction – instrumentation and applications.

Unit 3: **Chromatography** [13 h]

Thin layer chromatography - stationary phase, mobile phase, adsorbents, plate preparation, sample application, development, saturation of chamber, detection of spot, R_f values calculation, effect of adsorbent, solvent, solute, quantitative analysis and applications. Column chromatography – packing a column and application. Separation of biomolecules – electrophoresis, centrifugation of DNA and

proteins. Gas chromatography (GC), high-performance liquid chromatography (HPLC), GC-MS and LCMS – instrumentation, working principle and application.

Unit 4: Thermal Analysis [10 h]

Principle of thermogravimetry (TGA), differential thermal analysis (DTA), differential scanning calorimetry (DSC) - instrumentation and characteristics of TGA and DTA curves, factors affecting TGA and DTA curves. Applications - determination of purity of compounds by DSC, thermometric titrations, microthermal analyser – working principle and applications.

Unit 5: Surface Characterization Techniques [17 h]

Principle, instrumentation, working and applications of the following microscopic techniques- SEM, AFM, STM, STEM, TEM, confocal microscopy and fluorescence microscopy. Elemental composition - energy dispersive spectroscopy, UPS, XPS, Auger electron spectroscopy, selected area diffraction. Particle size analyzers, DLS, zeta potential, BET and electrochemical surface area analysis.

Recommended Reading

1. Karger, B.L., Snyder, L.R. and Horvath, C., 1973. Introduction to separation science.
2. Rousseau, R.W. ed., 1987. Handbook of separation process technology. John Wiley & Sons.
3. Skoog, D.A., West, D.M., Holler, F.J. and Crouch, S.R., 2013. Fundamentals of analytical chemistry. Cengage learning.
4. Skoog, D.A., Holler, F.J. and Nieman, T.A., 1998. Principles of instrumental analysis 5th edition. Saunders College Pub. Co.: Philadelphia.
5. Luo, Z., A Practical Guide to Transmission Electron Microscopy (Volume II).
6. Ul-Hamid, A., 2018. A beginners' guide to scanning electron microscopy. Cham, Switzerland: Springer International Publishing.
7. Thomas, S., Thomas, R., Zachariah, A.K. and Mishra, R.K. eds., 2017. Microscopy methods in nanomaterials characterization (Vol. 1). Elsevier.

25CHY383 Physical Chemistry Lab 0 0 6 2

CO Course Outcomes

CO01 Apply the physical chemistry concepts for determining different physical constants

CO02 Apply spectroscopy and electrochemistry for analytical determination

CO03 Achieve through knowledge in the instrumentation and application of different instruments

1. Conductance measurements and verification of Onsager equation
2. Determination of solubility of sparingly soluble salt-application Kohlrausch law
3. Preparation of buffers-use of Henderson equation
4. Determination of molecular weight of coordination complex by partition coefficient method.
5. Effect of current density on the thickness of anodised aluminium films
6. pH metric estimation of strong acids
7. Spectrophotometric estimation of iron in a water sample
8. Conductometric estimation of weak and strong acids in a mixture
9. Construction of phase diagram for two-component systems
10. Construction of three-component phase diagrams

11. Determination of molecular weight of metal complexes by partition coefficient method
12. Estimation of halides in a mixture by potentiometry
13. Spectrophotometric determination of molecular formula and weight of metal complexes
14. Determination of efficiency of corrosion-resistant films using linear polarization (Tafel plots).
15. Flame photometric estimation of metal ions in water and soil.
16. Estimation of sugars using polarimetry

Recommended Readings

1. Das. R.C. and Behara. B., 1983. 'Experiments in Physical Chemistry', Tata McGraw-Hill.
2. Findly. A., 1972.' Practical Physical Chemistry', 9th edition, Wiley.
3. Yadav, J.B.2010. 'Advanced Practical Physical Chemistry', Krishna Prakashan Media, 29th edition.
4. Shoemaker, D.P., Garland, C.W. and Steinfeld, J.I., 2018. *Experiments in physical chemistry*. McGraw-Hill.
5. Malati, M.A., 1999. *Experimental inorganic/physical chemistry: an investigative, integrated approach to practical project work*. Elsevier.
6. Atkins, P., Atkins, P.W. and de Paula, J., 2014. *Atkins' physical chemistry*. Oxford university press.

25CHY384 Advanced Inorganic Chemistry Lab 0 0 6 2

Students are expected to perform hands on synthesis, characterization and applications of inorganic materials. Topics include but are not restricted to the below points.

1. Nanomaterials
2. Co-ordination complexes
3. Mixed metal oxides
4. Organometallics
5. Biomimetics

The assessment is based on the practical skills in the lab, originality of the work and the written report, at the end of the course.

SEMESTER 6

25CHY313 Organometallic Chemistry 3 1 0 4

CO01 Analyze the stability, structure and reactivity of organometallic complexes with the sound knowledge of basic principles of organometallic chemistry.
CO02 Utilize modern instrumental techniques to characterize organometallic compounds and to identify the binding mode.
CO03 Apply the profound knowledge in various organometallic reactions types and mechanisms for efficient catalytic processes.
CO04 Elucidate the mechanism of homogeneous organometallic catalysts and apply this knowledge for large-scale and smaller-scale production of utility chemicals.

Unit 1: Concepts and Metal Carbonyls [12 h]

History and overview of organometallic compounds. Classification and nomenclature, classes of ligands, hapticity. 18-electron and 16-electron organometallic compounds. Metal carbonyls – synthesis and bonding, donor and acceptor properties of CO, binding modes of CO, polynuclear carbonyls, metal-metal bonding in M-CO clusters. Cluster valence electron (CVE) count - Wade-Mingos' rule, capping rule, Mingos' rule - CVE based structure prediction. IR spectral features of metal carbonyls. Reactions and activation of metal carbonyls. Metal nitrosyl (M-NO) compounds - bonding and structural features – comparison with metal carbonyl.

Unit 2: Structure and Bonding in Organometallic Compounds [12 h]

Fragment molecular orbitals (FMO) of various organic and inorganic moieties like CH_3, CH_2, CH, BH_2, BH, NH_2 and NH. Walsh's diagram of hetero di and triatomic molecule. Inorganic fragments MLn with varying number of L. Symmetry and shape of their FMO's. Isolobal concept, isoelectronic and isolobal relationships between various organic and inorganic fragments. Structure and bonding between various organic and inorganic fragments based on MO level diagrams.

Unit 3: Metal with Phosphine, Alkyl, Aryl and π-donor Ligands [10 h]

Metal phosphines compounds-bonding and structural features. Organometallic compounds with π-donor ligands like olefins, acetylenes and allyl moieties. Structure and bonding of metal derivatives of cyclic π-donors - metallocenes, sandwich/half-sandwich compounds, bent metallocenes, metal carbenes – Fischer carbenes and Schrock carbenes. Metal alkyl and aryl derivatives.

Unit 4: **Stereochemistry and Reactions of Organometallic Compounds** [12 h]

Stereochemically non-rigid molecules, fluxional nature of organometallic compounds, characterization of non-rigidity by spectroscopic methods. Reactions involving various organometallic compounds - oxidative addition, reductive elimination, migratory insertion -1,1 and 1,2-type insertion, elimination reactions, cyclometalation and ortho-metalation reactions and agostic interactions. Ligand substitution processes, nucleophilic and electrophilic additions – regioselectivity, and abstraction reactions. Coupling reactions, Pauson-Khand reaction and olefin oxidation.

Unit 5: **Industrial Applications of Organometallic Compounds** [14 h]

Homogeneous and heterogeneous organometallic catalysis - principle, mechanism and their applications. Alkene hydrogenation using Wilkinson's catalyst, water-gas shift reaction, Monsanto process and Cativa Process. Hydro-formylation reactions, Wacker process, Ziegler-Natta polymerization of alkenes, Fischer-Tropsch process, olefin-metathesis - Grubbs, Hoveyda–Grubbs and Schrock catalysts. Palladium based catalysts - Heck, Stille, Negishi, Suzuki-Miyaura, Sonogashira, Kumada, Hiyama and Buchwald-Hartwig couplings. Organometallic compounds as drugs, sensors, radiopharmaceuticals and tracers.

Recommended Readings

1. Crabtree, R.H., 2019. The organometallic chemistry of the transition metals. John Wiley & Sons.
2. Bochmann, M., 2000. Organometallics: Complexes with Transition Metal-carbon [sigma]-bonds. Oxford University Press on Demand.
3. Gupta, B.D. and Elias, A.J., 2010. Basic Organometallic Chemistry.
4. Atwood, J.D., 1997. Inorganic and organometallic reaction mechanisms. John Wiley & Sons.
5. Jack, R., Finke, R.G., Collman, J.P. and xanne Stehr, R., 1987. Principles and applications of organotransition metal chemistry. University Science Books.
6. Huheey, J.E., Keiter, E.A., Keiter, R.L. and Medhi, O.K., 2006. Inorganic chemistry: principles of structure and reactivity. Pearson Education India.
7. Gates, B. C., 1992. Catalytic chemistry. Wiley
8. Elschenbroich, C. and Salzer, A., 1992. A Concise Introduction. VCH.

25CHY314 Bioorganic and Natural Products Chemistry 3 1 0 4

Course Outcomes

CO1: Understand the chemistry of carbohydrates

CO2: Analyze the structure and reactivity of biomolecules like amino acids, peptides, and nuclic acids

CO3: Elucidate the structure, preparation, classification, and applications of Vitamins, Steroids, Enzymes, Hormones, Terpenoids, Alkaloids, and Lipids

CO4: Predict structure and function of proteins

CO5: Apply the structure and properties of biomolecules in life processes

Unit 1: Amino Acids, proteins and Peptides [12 h]

Amino acids – classification and synthesis. Peptides and proteins - structure and synthesis. Solid phase synthesis – choice of resin, classification and reactions leading to peptide formation - Boc and Fmoc strategies. Enzymes – classification. Enzyme inhibition and poisoning. Enzymes in organic synthesis.

Unit 2: Enzymes [10 h]

Enzymes – classification. Enzyme inhibition and poisoning. Enzymatic reactions with group transfer - hydrolysis, phosphorylation and transamination. Bio-catalyzed C-C bond formation and bond breaking reactions. Redox reactions – transfer of hydride. Monooxygenases and dioxygenases.

Unit 3: Carbohydrates and Nucleic Acids [14 h]

Nomenclature, classification and structure of mono and disaccharides, and mutarotation. Glucose and fructose - synthesis and reactions. Killiani synthesis, interconversions and Amadori rearrangement. Stereoisomerism – epimers and anomers. Disaccharides – properties and reactions of maltose, sucrose and lactose. Glycosides – classification and preparation. Oligo- and polysaccharides – structure, properties, reactions and applications of cellulose, starch and cyclodextrins. Synthesis of shikimic acid. Artificial sweeteners. Structure and synthesis of nucleic acids, deoxy sugars, genetic code and sequencing.

Unit 4: Steroids and Vitamins [10 h]

Steroids - classification, structural elucidation of cholesterol. Conversion of cholesterol to progesterone, androsterone, testosterone and vitamin D. Classification, structure, and synthesis of prostaglandins. Vitamins – classification, structure, source, uses, deficiency symptoms and diseases.

Unit 5: Alkaloids, Terpenoids and Flavonoids [14 h]

Alkaloids – classification, source and application. General methods of structural elucidation of alkaloids. Total synthesis of reserpine and quinine. Terpenes and terpenoids – isoprene rule, classification, structure and application of myrcene, limonene, geraniol and menthol. Biosynthesis and synthesis of menthol, camphor and β-carotene. Flavonoids - source and function in plants. Structure and synthesis of flavones, flavanols and flavanones.

Recommended Readings

1. Finar, I.L., 2002. Organic Chemistry, Volume 2: Stereochemistry and The Chemistry Natural Products, 5/E. Pearson Education India.
2. Bhat, S.V., Nagasampagi, B.A. and Sivakumar, M., 2009. Natural products: chemistry and applications. Alpha Science International.
3. Nicolaou, K.C. and Sorensen, E.J., 1996. Classics in total synthesis: targets, strategies, methods. John Wiley & Sons.
4. Kar, A., 2018. Chemistry of Natural Products, (Volume I and II), CBS
5. Voet, D. and Voet, J.G. 2010. Biochemistry, 4th Edition. John Wiley and Sons.

25CHY315 Molecular Spectroscopy 3 1 0 4

CO 01: Understand the theories underpinning rotational, vibrational, vibration-rotation, electronic spectra of molecules

CO 02: Interpret rotational, vibrational, vibration-rotation, electronic spectra of molecules

CO 03: Understand the theories underpinning spin resonance spectra

CO 04: Analyze and interpret spin resonance spectra of molecular moieties

Unit 1: Rotational Spectroscopy [6 h]

Interaction of electromagnetic radiation with matter. Factors affecting intensities and band widths of spectral lines. Origin of pure rotational spectra - diatomic and polyatomic molecules, selection rules, intensities of spectral lines. Instrumentation of microwave spectroscopy. Microwave spectra in determination of structure of molecules. Applications in analysis of chemistry of space.

Unit 2: Vibrational and Vibration-Rotation Spectroscopy [13 h]

Vibration spectra of diatomic molecules - harmonic and anharmonic vibrations. Selection rules - classical, quantum mechanical and symmetry. Vibrating rotator - Born-Oppenheimer approximation, rotational character of vibration spectra, origin of vibration-rotation spectra. Different modes of vibrations. Vibration spectra of polyatomic molecules. Fermi resonance. Instrumentation of FTIR spectrophotometer.

Unit 3: Raman Spectroscopy [11 h]

Classical and quantum mechanical theories on Raman scattering. Origin of rotational and vibrational Raman spectra. Instrumentation. Comparison between IR and Raman spectra - application of group theory - rule of mutual exclusion.

Unit 4: Electronic Spectroscopy [12 h]

Electronic spectra of atoms - single and multi electron systems, j-j and L-S coupling. Electronic spectra of diatomic and polyatomic molecules - vibrational fine structure, Frank-Condon principle. Selection rules. Application of group theory in electronic spectra. Theory of fluorescence spectroscopy – quantum yield, lifetime.

Unit 5: Spin Resonance Spectroscopy [18 h]

Nuclear Magnetic Resonance - Classical and quantum mechanical approach - nuclear spin, magnetic moment, nuclear magnetic resonance, chemical shift, spin-spin coupling, relaxation processes. Dynamic NMR spectroscopy. Multiple resonance techniques. 2D and solid state NMR. Instrumentation of NMR – sampling. Spectra involving ^{1}H, ^{13}C, ^{19}F and ^{31}P nuclei. **Electron Spin Resonance -** Theory - electron spin, magnetic moment, electron spin resonance, hyperfine structure, line width and anisotropy. Dynamic ESR. Triplet state in ESR. Double resonance techniques. Instrumentation. ESR spectra of organic and inorganic compounds. **Nuclear Quadrupolar Resonance -** Theory - Nuclear quadrupolar moment, electric field gradient, the asymmetry parameter, nuclear quadrupolar transitions involving axially symmetric and axially non-symmetric molecules. Applications of NQR to analyze chemical bonding, molecular structure, solid state effects and hydrogen bonding.

Recommended Readings

1. Banwell, C.N. and McCash, E.M., 2017. Fundamentals of molecular spectroscopy. McGraw-Hill.
2. Hollas, J.M., 2004. Modern spectroscopy. John Wiley & Sons.
3. Sathyanarayana, D.N., 2020. Introduction to Magnetic Resonance Spectroscopy ESR, NMR, NQR. IK International Publishing House Pvt. Limited.
4. Sathyanarayana, D.N., 2015. Vibrational spectroscopy: theory and applications. New Age International.
5. Sathyanarayana, D.N., 2001. Electronic absorption spectroscopy and related techniques. Universities Press.
6. Sathyanarayana, D.N., 2020. Handbook of Molecular Spectroscopy: From Radio Waves to Gamma Rays. Wiley.

7. Drago, R.S., 2012. Physical methods in inorganic chemistry, Affiliated East.
8. Pavia, D.L., Lampman, G.M., Kriz, G.S. and Vyvyan, J.A., 2014. Introduction to spectroscopy. Cengage learning.
9. Kemp, W., 2017. Organic spectroscopy. Macmillan International Higher Education.
10. Silverstein, R M, F. X. Webster, F.X, Kiemle, D.J., Spectrometric identification of organic molecules (8th edition). John Wiley
11. Skoog, D.A., Holler, F.J. and Crouch, S.R., 2007. Instrumental analysis (Vol. 47). Belmont: Brooks/Cole, Cengage Learning.

25CHY316 Statistical and Irreversible Thermodynamics 3 1 0 3

CO Course Outcomes

CO01 Understand the basics of mathematical operations involved in statistical thermodynamics

CO02 Apply entropy of mixing and partition functions to treat thermodynamics systems

CO03 Achieve comprehensive knowledge on irreversible thermodynamics and apply this for different thermodynamic phenomena

Unit 1: Fundamental Statistics for Thermodynamics [4 h]

Probability. Permutations and combinations. Probability distributions - discrete and continuous binomial, Poisson and Gaussian distributions. Combinatorial analysis for statistical thermodynamics - distinguishable objects and indistinguishable objects.

Unit 2: Statistical Thermodynamics - I [9 h]

Thermodynamic probability. Entropy and probability. Phase space. Ensembles and ensemble average - microcanonical ensemble, entropy of a perfect gas, entropy of mixing of ideal gases and Gibbs paradox, canonical ensemble, grand canonical ensemble. General formulations of Maxwell-Boltzmann, Fermi-Dirac and Bose-Einstein statistics.

Unit 3: Statistical Thermodynamics - II [12 h]

Partition function for poly atomic molecules - partition function for free linear motion, free motion in a shared space, linear harmonic vibrations, translational, rotational and vibrational partition functions, molecular partition functions, partition functions and thermodynamic properties, calculation of equilibrium constant. Heat capacity - classical and quantum statistical theory of specific heat residual entropy.

Unit 4: Irreversible Thermodynamics [10 h]

Examples for irreversible process. Steady state and near equilibrium conditions. Linear relations - phenomenological coefficients, Onsager reciprocal relations. One component system with heat and mass transport - entropy production. Heat and mass transport in multicomponent systems. Principle of macroscopic reversibility and Onsager's reciprocal relations. Verification of Onsager relations.

Unit 5: Irreversible Thermodynamics [10 h]

Application of irreversible thermodynamics - thermoelectricity, electro-kinetic phenomena, thermomolecular pressure difference, mechanocaloric effects, transference in aqueous solutions of electrolytes. Stationary non-equilibrium state. Irreversible thermodynamics for the non-linear regime. Chemical reactions and molecular machines. Applications of irreversible thermodynamics to biological systems.

Recommended Readings

1. Atkins, P., Atkins, P.W. and de Paula, J., 2018. Atkins' physical chemistry. Oxford university press.
2. Laurendeau, N.M., 2005. Statistical thermodynamics: fundamentals and applications. Cambridge University Press.
3. Glasstone, S., 1947. Thermodynamics for chemists (No. 541.369). D. Van Nostrand,.
4. Rastogi, R.P., 2009. An Introduction To Chemical Thermodynamics. Vikas Publishing House.
5. Rajaram, J., 2013. Chemical thermodynamics: Classical, statistical and irreversible. Pearson Education India.
6. Lebon, G., Jou, D. and Casas-Vázquez, J., 2008. Understanding non-equilibrium thermodynamics (Vol. 295, p. 15). Berlin: Springer.
7. Prigogine., 1968. Introduction to Thermodynamic Irreversible Processes, Interscience Publishers.
8. Sears, F.W., Salinger, G.L. and Lee, J.E., 1975. Thermodynamics, kinetic theory, and statistical thermodynamics. Addison-Wesley.
9. B. R. Puri, B.R., Pathania, M.S., L. R. Sharma, L.R., 2020, Principles of physical Chemistry, Vishal Publishing Co.
10. Hill, T.L., 2003. An introduction to statistical thermodynamics. Courier Corporation.
11. Swendsen, R., 2020. An introduction to statistical mechanics and thermodynamics. Oxford University Press, USA.

25CHY385 Advanced Organic Chemistry Lab 0 0 6 2

Students are expected to try various approaches in organic synthesis and characterization. The assessment is based on the practical skills in the lab, originality and the written report at the end of the course. Topics include but are not restricted to the below points.

1. Multicomponent reactions
2. Multi-step synthesis
3. Metal free catalysis
4. Bio active molecules synthesis

SEMESTER 7

25CHY401 Solid State Chemistry 3 0 0 3

CO01 predict the various types of crystal structures and possible symmetry operations in the crystals.

CO02 apply the basic rules in predicting the electronic, optical, and magnetic properties.

CO03 predict the type of crystal structure using various characterization tools.

Unit 1: Crystal structure and symmetry [10 h]

Elements of symmetry in crystal systems, proper rotation, mirror planes, inversion, improper axis symmetry elements, Schoenflies and Hermann-Mauguin notations, unit cells, glide plane, screw axis, atom occupancy in cubic unit cells, Space groups. Spinel and inverse spinel, perovskite structures, ionic radii, crystal radii, radius ratio. Extended covalent array, diamond, graphite.

Unit 2: Electronic properties of solids [12 h]

Free electron theory, density of states, electronic conductivity, molecular orbital theory, overlap and bonding, linear chain of H atoms, LCAO, Fermi Level, conductors, insulators and semiconductors, n- and p-type semiconductors, bands in compounds, band-gap energy, direct and indirect band gaps in semiconductors, band-gap measurements, electrical conductivity. Organic conductors, preparation, mechanism of conduction in organic semiconductors - applications, photoconductivity of polymers. Superconductivity- mechanism - BCS theory – examples – high temperature superconductors. Electronic properties of nanosolids. Introduction to Dielectric, Ferro, Peizo, Pyro electrics

Unit 3: Magnetic properties of solids [7 h]

Behavior of substances in a magnetic field, magnetic moments, Types of magnetic materials - paramagnetism, diamagnetism, ferro- and anti-ferromagnetism, ferri-magnetism, effects of temperature of magnetism, Curie & Curie-Weiss laws; mechanism of ferro- and anti-ferromagnetic ordering, super exchange.

Unit 4: Optical properties of solids [6 h]

Luminescence and phosphorescence of solid materials, phosphors, materials for lighting, doping in crystals and colour features, ruby, diamond. Optical properties of nano solids.

Unit 5: Characterization tools for solids [10 h]

X-ray diffraction - Bragg's equation and experimental methods (powder method and rotating crystal technique), phase identification and analysis of crystallite size. Magnetic characterization: Vibration Sample Magnetometer.

Recommended Readings

1 Woodward, P.M., Karen, P., Evans, J.S. and Vogt, T., 2021. Solid State Materials Chemistry. Cambridge University Press.

2 Azaroff, L.V., 2017. Introduction to solids. Tata Mcgraw hill publishing company.

3 Smart, L.E. and Moore, E.A., 2021. Solid state chemistry: an introduction. CRC press.

4 West, A.R., 2014. Solid state chemistry and its applications. John Wiley & Sons.

5 Ooi, L.L., 2010. Principles of X-ray Crystallography. Oxford University Press.

6 Egerton, R.F., 2005. Physical principles of electron microscopy. New York: Springer.

7 Kuzmany, H., 2009. Solid-state spectroscopy: an introduction. Berlin: springer.

8 Müller, K. and Geppi, M., 2021. Solid State NMR: Principles, Methods, and Applications. John Wiley & Sons.

9 Franco, V. and Dodrill, B. eds., 2021. Magnetic Measurement Techniques for Materials Characterization. Springer International Publishing.

10 Dann, S.E., 2000. Reactions and characterization of solids (Vol. 2). Royal Society of Chemistry.

11 Bhushan, B., Luo, D., Schricker, S.R., Sigmund, W. and Zauscher, S. eds., 2014. Handbook of nanomaterials properties. Springer Science & Business Media.

25CHY402 Physical Methods in Chemistry 3 0 1 4

Course outcomes

CO01 understand the basic principle involved in electronic, vibrational, mass and NMR spectroscopy.

CO02 analyze the spectroscopic information to find the structural information of molecules.

COO3 elucidate the structure of the compound using the spectral data for the analysis

Unit 1: UV-Visible and Fluorescence Spectroscopy [10 h]

Laws of absorption. Type of electronic transitions – allowed and forbidden transitions. Chromophore and auxochromes. Factors governing absorption maximum and intensity. Woodward Fieser and Fieser-Kuhn's rules - calculation of λ_{max} for simple organic molecules. Fluorescence and phosphorescence - principles, Stokes shift, quantum yield and application. Instrumentation of UV-Visible and fluorescence spectroscopy.

Unit 2: Infrared Spectroscopy [8 h]

Hook's law, vibrational frequency, modes of vibrations, and selection rules. Instrumentation - sampling techniques. Fingerprint and functional group region. Factors influencing vibrational frequency. Interpretation of the IR spectra of organic molecules with various functional groups.

Unit 3: ^{1}H NMR Spectroscopy [12 h]

Theory, relaxation effects, NMR active nuclei. Instrumentation – magnetic shimming. Chemical shift, magnetic anisotropic effect, spin-spin splitting, n+1 rule, j-j coupling, measurement of J. Karplus relationship, first and second order spectra, double resonance, spin tickling and chemical shift reagents. Spectra of conformational isomers - homotopic, enantiotopic and diastereotopic systems. Nuclear

Overhauser effect (NOE). Variable temperature NMR. Application of ^{1}H NMR for the structural elucidation of organic compounds. MestReNova – Introduction and data analysis.

Unit 4: ^{13}C, 2D and 3D NMR spectroscopy [16 h]

^{13}C NMR – theory. ^{1}H coupled and decoupled ^{13}C spectra, chemical shift values. Attached proton test (APT), distortionless enhancement by polarization transfer (DEPT), incredible natural abundance double quantum transfer experiment (INADEQUATE). ^{13}C NMR spectroscopy for the structural elucidation of organic compounds. ^{11}B, ^{15}N, ^{19}F and ^{31}P NMR spectra. 2D-NMR- examples and interpretation of homonuclear (COSY, NOESY, TOCSY) and heteronuclear (HMQC, HSQC) NMR. Introduction to 3D NMR.

Unit 5: Mass Spectrometry [14 h]

Instrumentation – methods of ionisation - EI, CI, APCI, ESI, MALDI and FAB. Mass analyser – magnetic and electrostatic sector, time of flight and quadrupole. Molecular ion, base peak, multicharged ion, metastable ions and isotope ratio. Fragmentation patterns of saturated, unsaturated and aromatic hydrocarbons, alcohols, phenols, aldehydes, ketones, carboxylic acids, esters, amines, nitro, nitrile and halides. McLafferty rearrangement. Quantitative analysis using mass spectra.

Structural elucidation using UV-Visible, IR, ^{1}H NMR, ^{13}C NMR and MS

Recommended Readings

1. D. L. Pavia, G. M. Lampman, G. A. Kriz, and J. R. Vyvyan, 2009. Introduction to Spectroscopy, 5th Edition, Brooks-Cole.
2. W. Kemp, 1988. Organic Spectroscopy, 3rd Edition, McMillan International Higher Education.
3. Silverstein, R.M. and Bassler, G.C., 2015. Spectrometric identification of organic compounds, 8th edition. Wiley
4. Hollas, J.M., 2004. Modern spectroscopy. John Wiley & Sons.
5. Günther, H., 2013. NMR spectroscopy: basic principles, concepts and applications in chemistry. John Wiley & Sons.
6. Dyer, J.R., 1965. Applications of absorption spectroscopy of organic compounds. Prentice Hall India Learning Private Limited
7. Hoffmann, E., and Stroobant. V. 2001. Mass spectrometry-principles and applications.
8. Fleming, I. and Williams, D.H., 2007. Spectroscopic methods in organic chemistry. New York: McGraw-hill.

25CHY403 Bioinorganic Chemistry 3 0 0 3

CO1: apply the principles of coordination and organometallic chemistry in the interpretation of biological functions.
CO2: Predict the interaction of specific metal ions with biological environments.
CO3: Explicate how the nature adapts certain properties of metal centres for specific applications and its role in metalloenzymes for catalysing reactions that are energetically and stereo selectively difficult.
CO4: Describe the mechanism of metalloenzymes by applying the suitable spectroscopic and other analytical techniques.
CO5 Explain the role of metal ions as diagnostic and therapeutic agent and the mechanism of metal toxicity.

Unit 1: Reactive Oxygen Species and Macrocyclic Ligands [7 h]

Essential elements in biological systems, transport of ions across biological membranes, active and passive transport. Reactive oxygen species (ROS), generation and function of free radicals, action of ROS in biological systems, oxidative stress and antioxidants. Structure of macrocyclic ligand (porphine and corrin). Hydroporphyrins (H_2P) and metalloporphyrins (MP) - spectral, fluorescence and redox properties. Chemistry of Chlorophyl.

Unit 2: Uptake, Transport and Storage of Oxygen and Iron [10 h]

Myoglobin (Mb) and haemoglobin (Hb) - prosthetic groups and functions, mechanism for reversible binding of O_2. Cooperative effect in Hb and its consequences. Behaviour of bound O_2 to Fe(II). Difference between O_2 and CO binding to Hb and Mb and CN^- poisoning. Sickle-cell anaemia. 'Picket-fence' porphyrin and its special features. Haemerythrin and haemocyanin – structure, functions, O_2 binding and electron transfer. Fe-S and other non-haeme iron proteins, ferredoxins - structure and special properties. Uptake, transport and storage of iron - transferrin, ferritin, siderophores and enterobactin.

Unit 3: Metalloenzymes – I [12 h]

Structure, properties and reaction mechanism of catalases, peroxidases - glutathione peroxidase, HRP and cytochrome C peroxidase, cytochromes - cytochrome P-450, cytochrome C-oxidase and monooxygenases. Electron transport in biology, electron transport chain. Structure and enzymatic reaction mechanisms of superoxide dismutase and tyrosinase. Copper containing enzymes - azurin, plastocyanin - structure and function. Type I, II and III copper proteins. Zinc containing enzymes - carbonic anhydrase, carboxy peptidase - structure and enzymatic reactions. Vitamin B_{12} – nomenclature, structure, enzymatic reaction and its model compounds.

Unit 4: Metalloenzymes – II [7 h]

N_2 fixation, nitrogenase enzyme, Fe-S clusters, Fe-protein structure, Mo-Fe protein structure, P-cluster and M-centre. Bioinorganic Chemistry of photosynthesis (PS-I and PS–II). Role of Mn, Ni, Mo and Cr in biological systems.

Unit 5: Metals in Medicine [9 h]

Metal ion based (V, Fe, Au and Pt) drugs and anticancer agents. Cis-platin and its properties. Chelation therapy, macrocyclic antibiotics, therapeutic complexes, DNA intercalators and diagnostic agents. Photodynamic therapy - principles and applications. Natural and synthetic ionophores and crown ethers - interaction and uptake of alkali metal and alkaline earth metal ions with crown ethers, cryptands, cryptates, calixarenes and cyclodextrins. Metal toxicity and homeostasis. Diseases caused by both excess and deficiency of metal ions, thalassaemia, Wilson disease. Heavy metal toxicity – mercury, arsenic and chromium poisoning.

Recommended Readings

1. Bertini, I., Gray, H.B., Lippard, S.J. and Valentine, J.S., 2007. Bioinorganic chemistry. University science books.
2. Stephen J. L, Jeremy M. B, 1994. Principles of bioinorganic Chemistry, University Science Books.
3. Greenwood, N.N. and Earnshaw, A., 2012. Chemistry of the Elements. Elsevier.
4. Bertini, G., Gray, H.B., Gray, H., Valentine, J.S., Stiefel, E.I. and Stiefel, E., 2007. Biological inorganic chemistry: structure and reactivity. University Science Books.
5. Da Silva, J.F. and Williams, R.J.P., 2001. The biological chemistry of the elements: the inorganic chemistry of life. Oxford University Press.
6. Berg, J.M., Tymoczko, J.L. and Stryer, L., 2002. Biochemistry.

25CHY404 Frontiers in Organic Chemistry 3 1 0 4

CO1: Explore various light induced reactions in organic chemistry.

CO2: Apply the basic principles of bonding in ground state and excited state to establish different reaction mechanisms.

CO3: Analyze the effect of energy transfer on the different reaction mechanisms.

CO4: Explain reaction mechanism with the help of molecular orbital theory.

CO5: Elucidate the synthesis of different bioactive molecules.

Unit 1: Pericyclic Reactions – I [12 h]

Molecular orbital symmetry. Frontier orbitals of ethylene, 1,3-butadiene, 1,3,5-hexatriene and allyl system. Classification of pericyclic reactions. Electrocyclic reactions – con rotation and dis rotation in 4n, 4n+2, allyl systems and secondary effects. Electrocyclization of charged species and heteroatomic trienes.

Unit 2: Pericyclic Reactions – II [14 h]

Cycloaddition reactions - antrafacial and suprafacial additions, 4n and 4n+2 systems with (2+2) and (4+2) cycloadditions. Effect of stereochemistry and substituents on the rate of cycloadditions, 1,3-dipolar cycloadditions and cheleotropic reactions. Sigmatropic rearrangements - suprafacial and antrafacial shifts - [1,2]-sigmatropic shifts involving carbon moieties. [m,n] and [m,m] sigmatropic

hydrogen shifts. Claisen, Cope, Wittig and aza–Wittig rearrangements, fluxional tautomerism. Ene reactions.

Unit 3: Photochemistry – I [10 h]

Photochemistry of alkenes- intramolecular reactions, geometrical isomerism, cyclisation reactions. Photochemical rearrangements - 1,4 and 1,5- dienes. Photochemistry of aromatic compounds - isomerizations, additions, substitutions and photo reduction.

Unit 4: Photochemistry – II [14 h]

Photochemistry of carbonyl compounds - Norrish type I and type II, and Patterno–Buchi reactions. Intramolecular reactions of carbonyl compounds – saturated cyclic and acyclic, α,β and β,γ-unsaturated compounds, cyclohexanone, cyclohexadienones. Intermolecular cycloaddition reactions and dimerisations. Photo-Fries reactions and rearrangements, Lumiketone rearrangement and Barton reaction. Photo reduction of carbonyl compounds. Singlet molecular oxygen reactions. Photostabilizers.

Unit 5: Heterocyclic Compounds [10 h]

Biologically important heterocycles, Hantzsch-Widman system for monocyclic, fused and bridged heterocycles. Aromaticity of one, two, three, four, five, six and fused heterocycles. Physical and Chemical properties of various heterocyclic compounds.

Recommended Readings

1. Carey, F.A. and Sundberg, R.J., 2007. Advanced organic chemistry: part A: structure and mechanisms. Springer Science & Business Media.
2. Carey, F.A. and Sundberg, R.J., 2007. Advanced organic chemistry: part B: reaction and synthesis. Springer Science & Business Media.
3. Smith, M.B., 2020. March's advanced organic chemistry: reactions, mechanisms, and structure. John Wiley & Sons.
4. Sankararaman, S., 2005. Pericyclic Reactions-A Textbook: Reactions, Applications and Theory. Wiley-VCH.
5. Singh, N.D., 2014. Organic photochemistry and pericyclic reactions.
6. Klán, P. and Wirz, J., 2009. Photochemistry of organic compounds: from concepts to practice. John Wiley & Sons.

25CHY481 Advanced Physical Chemistry Lab 0 0 6 2

This course involves the analysis of various physical chemistry parameters of materials and the study of their applications. This will provide hands-on skills in synthesis, characterization, reaction kinetics, interpretation, statistical treatment, and documentation of experimental data. Topics include but are not restricted to the below points.

1. Synthesis of nanomaterials and their characterization by various electroanalytical techniques for energy storage, corrosion, and biosensing applications
2. Spectrophotometric estimations of environmental pollutants
3. Surface functionalization of nanomaterials and their characterization for various applications

Study of spectrophotometric, electrochemical, and catalytic applications of transition metal complexes

25RM500 Research Methodology 2 0 0 2

CO1: Explore the purpose and importance of research for future development.
CO2: Develop intellectual abilities in designing research protocols.
CO3: Acquire abilities in designing and developing models for data handling.
CO4: Develop abilities on data analysis and interpretation.
CO5: Create insight into adequate report preparation and presentation

Unit 1: Ethics in Research

Ethics, moral philosophy, nature of moral judgements and reactions. Scientific conduct - ethics with respect to science and research. Intellectual honesty and research integrity. Scientific misconducts - falsification, fabrication and plagiarism. Redundant publications - duplicate and overlapping publications. Selective reporting and misrepresentation of data.

Unit 2: Literature Survey

Importance of literature survey, planning a literature search, identifying key concepts and key words, locating relevant literature and reliability of a source.

Aim, objectives, expected outcome, and methodology to be adopted. Importance of reproducibility of results. Objectives and basic principles of designs of experiments. Data presentation - using graphs, in tables, schemes and figures. Software for drawing. Bibliography using Mendeley and Zotero.

Unit 4: Publication Ethics

Best practices and standards, conflicts of interest, publication misconduct, unethical behaviour and related problems. Authorship and contributorship. Identification of publication misconduct, complaints and appeals.

Unit 5: Research Communication

General aspects of scientific writing - reporting practical and project work, writing literature survey and reviews, organizing a poster display, oral presentation. Guidelines for manuscript writing -

abstract, introduction, methodology, results and discussion, conclusion, acknowledgement, references and citation. Intellectual property (IP) and intellectual property rights (IPR).

Recommended Readings

1. Bird, A., 2006. Philosophy of science. Routledge.
2. MacIntyre, A., 2017. A short history of ethics: A history of moral philosophy from the Homeric age to the twentieth century. University of Notre Dame Pess.
3. Chaddah, P., 2018. Ethics in Competitive Research: Do not get scooped; do not get plagiarized.
4. Bordens, K.S. and Abbott, B.B., 2002. Research design and methods: A process approach. McGraw-Hill.
5. Kothari C.R., 2020. Research methodology methods and Techniques. New Age International Publishers.
6. Thomas, C.G., 2021. Research methodology and scientific writing. Thrissur: Springer.

Semester 8

25CHY411 Advanced Synthetic Organic Chemistry 3 1 0 4

Course Outcome

CO1: Analyze diverse reactions of heterocyclic compounds
CO2: Predict organic reaction mechanism using advanced reagents
CO3: Explore basic ideas of multi-component reactions
CO3: Apply biosynthesis mechanism in biomimetic preparation of various biomolecules
CO4: Analyze principles of green chemistry and implement them for real-life problems.

Unit 1 - Heterocyclic compounds

Nomenclature and general characteristics of heterocyclic compounds, study of three and four-membered ring heterocyles containing one heteroatom, Pauson- khand reaction, Bergman's cyclisation, Nazarov cyclisation, Mitsunobu reaction, cation – olefin cyclisation and radical olefin cyclisation, inter conversion of ring systems (contraction and expansion) - Demjenov reaction. Structure and synthesis of penicillin and cephalosporin-C, structure and synthesis of reserpine, heteroaromatic compounds (five and six-membered rings) containing one and two heteroatoms, fused ring compounds - coumarin, flavones, Name reactions involving heterocyclic chemistry – Bartoli reaction, Corey – Chykovsky reaction

Unit 2 - Reagents in organic synthesis

Preparation, properties and reactions of organoboron, organosilicon, organotin, organozinc and organomagnesium, organocadmium, organomercury, organopalladium, organonickel, organocobalt, organorhodium and organoruthenium reagents. Wacker process, Coupling and cross coupling, carbonylation reaction, Olefin metathesis reaction.
Hydride transfer reagents from Group III and Group IV in reductions - $LiAlH_4$, DIBAL-H, Red-Al, $NaBH_4$ and $NaCNBH_3$, selectrides, trialkylsilanes and trialkyl stannane. Aluminum isopropoxide (oxidation and reduction). Reagents such as NBS, DDQ and DCC, Gilmann reagent, DMAP-Borane, $DMF/POCl_3$, PCC, DEAD, TEMPO, DMSO, $Cu(OAc)_2$, $NaIO_4$, B_2H_6/H_2O_2, Reduction with N_2H_4 and N_2H_2.

Unit 3 - Ring closure and multi-component reactions

Ring closure reactions - Macrolactonisation, iodolactonisation, selenolactonization, cycloadditions induced by sulphur reagents, α-halogenations, sulfenylation and selenylation of carbonyl compounds, Reactions by metallocarbenes - Grubbs and Schrock catalyst.

Multicomponent reactions - Introduction to MCR, Passserini reaction, Ugi reaction, Biginelli reaction. Introduction to combinatorial chemistry and click chemistry and its applications. Phase transfer catalysis and its application in organic synthesis.

Unit 4 - Biosynthesis and biomimetic synthesis

Basic principles of biosynthesis of terpenes, steroids, alkaloids, carbohydrates and cyclodextrins. Preparation of alditols, proteins and nucleic acids. Biosynthesis of cholesterol, alpha-terpenol, morphine. Biomimetic synthesis of progesterone. Synthesis of prostaglandins, biosynthesis of fatty acids, steroids. Total synthesis of quinine, and heroin, Synthesis of abietic acid and shikimic acid.

Unit 5 Green synthesis

Principles of Green Chemistry: basic concepts, atom economy, twelve principles of Green Chemistry, principles of green organic synthesis. Green alternatives to Organic Synthesis: coenzyme catalysed reactions, thiamine catalyzed benzoin condensation. Green alternatives of molecular rearrangements: pinacol-pinacolone and benzidine rearrangements. Electrophilic aromatic substitution reactions. Oxidation-reduction reactions. Clay catalyzed synthesis. Condensation reactions. Green photochemical reactions. Green Solvents: ionic liquids, supercritical CO_2, fluorous chemistry, general principles of microwave and ultrasound assisted organic synthesis.

TEXT BOOKS

1. *I. L. Finar Organic Chemistry vol 2 (3rd.ed.) Longmans Green & Co. 1964.*
2. *Gilchrist, T. L., Heterocyclic Chemistry, 2nd edition, Pitman Publishing, London, 1985.*
3. *Michael B Smith, "March's Advanced Organic Chemistry: Reactions, Mechanisms and Structure", 7th edition, Wiley (2015).*
4. *Francis A. Carey and Richard J. Sundberg, "Advanced Organic Chemistry – Part B: Reactions and Synthesis", 5th Edition, Springer, 2008.*
5. *Singh S. P. and S. M. Mukherji, "Reaction Mechanism in Organic Chemistry", 2014*

REFERENCES

1. *Raj K. Bansal, Heterocylic chemistry, 5th edition, New age International publishers, London, 1990.*
2. *Reinhard Bruckner, Advanced Organic Chemistry, Reaction Mechanisms, Elsevier, 2002*
3. *R.O.C. Norman and J.M. Coxon, "Principles of organic synthesis", CRC press, 2014*
4. *Biomaterials –novel materials from biological sources D. Byrom - Stockton press*
5. *Handbook of Biodegradable polymers Catia Bastioli, - Rapra Tech*
6. *Surface modification of biomaterials: Methods analysis and applications R Williams - University of Liverpool, UK*

Biopolymers,R.M. Johnson, L.Y. Mwaikambo and N. Tucker Handbook of Bioplastics & Biocomposites for Engineering Applications Srikanth Pillai

25CHY412 Industrial Inorganic Chemistry 3 1 0 4

Course objectives

1. To improve the student's knowledge of the basic information for industrial requirements and methods of preparation.
2. To develop awareness on the contributions of chemistry to society.
3. To develop awareness on the scope of chemist in chemical industry.

Course Outcomes

CO1 Understand the fundamental chemical principles involved in industrial chemistry.
CO2 Acquire a thorough knowledge on the various properties of the material.
CO3 Acquire a deeper understanding on the various manufacturing processes employed in the production of chemicals.
CO4 apply their basic understanding in developing various inorganic materials for industrial application.

Unit 1 Inorganic solids

Glass – introduction, Properties and classification silicate and non-silicate glasses. Manufacture and processing of glass. Composition and properties of the following types of glasses: Soda lime glass, lead glass, safety glass, borosilicate glass, fluorosilicate, colored glass, photosensitive glass.

Unit 2 Ceramics

Introduction – classification of ceramic products, composition and raw materials, manufacture of ceramics, properties and application of ceramic products. Manufacture and properties of carbide based ceramics. Oxide ceramics and their industrial applications.

Unit 3 Inorganic pigments

Introduction, white, coloured and black pigments – physical and chemical properties – production of pigments, Toxicology and Environmental Aspects, pigments for various applications. Specialty Pigments – properties, production and application.

Unit 4 Mineral Fertilizers:

Phosphorus-Containing Fertilizers, Economic Importance, manufacture of phosphate containing fertilizers, Nitrogen-Containing Fertilizers: Economic Importance, Importance of Urea, Manufacture of Nitrogen-Containing Fertilizers, Potassium Containing Fertilizers: Occurrence of Potassium Salts, Manufacture of Potassium-Containing Fertilizers.

Unit 5 Inorganic Industrial catalyst

Introduction to Heterogeneous catalysis-electronic and geometric factors, industrial catalytic applications of zeolites, aluminophosphates, mesoporous materials, aminophosphates, hydrotalcite, clays, nanocomposites and metal organic frameworks.

Reference books

1. Karl Heinz Buchel, Hans-Heinrich Moretto, Peter Woditsch, Industrial Inorganic Chemistry, Wiley-VCH, revised edition, 2003
2. G. Buxbaum and G. Pfaff, Industrial Inorganic Pigments, 3rd edition, Wiley-VCH, 2005.

25CHY413 Industrial Electrochemistry 3 1 0 4

CO1: Apply the basic concepts in electrochemistry for the industrial plating of different protective metals
CO3: Analyze anodization process for corrosion protection and metal finishing
CO3: Apply the principles of electrochemical energy storage fabrication and its working
CO4: Understand various methods for the recycling of lithium batteries

Unit 1: Electrodeposition: Review of thermodynamics, kinetics and quantitative electrochemistry, Industrial plating of copper-nickel (dull and bright) - chromium on mild steel – operating conditions and sequence – pre-treatment processes - plant layout – electroplating of zinc on MS and post plating chromating, yellow and blue passivation processes – decorative plating of silver and gold on non-ferrous metals– brief discussion on nano plating of metals and microstructure of the deposition. Properties of deposits: Tests for adhesion, hardness, thickness, uniformity and corrosion resistance of the electro deposits. Electroless deposition: Nickel, copper, gold on metal components – bath composition and operating conditions - immersion plating - plating on plastics – pre-treatment processes – long duration plating – electroforming, operating conditions and sequence. (14 hours)

Unit 2: Anodising: Industrial anodizing of aluminium and its alloys – baths used, operating conditions and sequence – plant layout – effect of temperature and current density on the thickness of anodic film – determination of thickness – industrial applications. Nano anodizing of titaniuim, aluminium and tantalum – application to sensor field. Plasma electrolytic oxidation: power supply requirements – baths used – process sequence for aluminium, magnesium and titanium – properties of the coating and industrial applications. Electropolishing: electropolishing of ferrous and non-ferrous metals – industrial baths used – operating conditions and sequence industrial applications. (13 hours)

Unit 3: Electrochemical etching: Etching of ferrous and non-ferrous metals – special properties of matt and satin finish – DC and AC processes – operating conditions and sequence. Electrochemical and chemical metal colouring of ferrous and nonferrous metals. Black nickel coating – Hard chromium deposition – Hard anodizing of aluminium Electrochemical machining of hard steels – Electro-winning process – Barrel plating– Electrodeposition of paint. (10 hours)

Unit 4: Energy storage devices: Batteries-primary, secondary, construction and working of Duracell, Metal air batteries, lead acid batteries and lithium-ion batteries. Reserve batteries, redox flow batteries. Fuel cells-hydrogen, methanol, solid oxide, biofuel cells. Supercapacitors and Green hydrogen production. Battery characteristics-Ragone plots, Peukert curves. (10 hours)

Unit 5: Lithium battery recycling: Potential environmental impact of spent lithium-ion batteries, pretreatment of spent lithium-ion batteries for recycling processing, pyrometallurgical processing for recycling spent lithium-ion batteries, hydrometallurgical processing for recycling spent lithium-ion batteries, direct processing for recycling spent lithium-ion batteries; high value-added products from recycling of spent lithium-ion batteries. (13 hours)

Suggested Reading

1. Derek Pletcher and Frank C. Walsh, 'Industrial Electrochemistry', Blackie Academic and Professional, (1993).
2. Christopher M A, Brett, 'Electrochemistry – Principles, Methods and Applications', Oxford University, (2004).
3. Linden, D., 1995. Handbook of batteries. In *Fuel and energy abstracts* (Vol. 4, No. 36, p. 265).
4. Liang, A., 2019. Recycling of Spent Lithium-Ion Batteries: Processing Methods and Environmental Impacts.
5. Watanabe T, 'Nano-plating: microstructure control theory of plated film and data base of plated film microstructure', Elsevier, Oxford, UK (2004).
6. Kanani N, 'Electroplating and electroless plating of copper and its alloy', ASM International, Metals Park, OH and Metal Finishing Publications, Stevenage, UK (2003). 1. Curtis, 'Electroforming', London, (2004).
7. Rumyantsev E and Davydov A, 'Electrochemical machining of metals', Mir, Moscow, (1989).
8. Peter G Sheasby 'Basics of aluminium anodising', Banbury, Oxon (2001)
9. Robert Brugger 'Nickel Plating' Robert Draper Ltd, Teddington, (1970)
10. J.K.Dennis, T.E.Such, 'Nickel and Chromium Plating, Third Edition' Woodhead Publishing Series in Metals and Surface Engineering, 3rd Edition, (1993

❖ List of Elective UG Papers:

25CHY371 Batteries and Fuel Cells 3 0 0 3

CO1: Get the knowledge about fundamentals of electrochemistry which involves origin of potential, calculation of EMF of cell, Nernst equation etc.
CO2: Awareness on types, working, applied areas, advantages as well as disadvantages of primary and secondary batteries.
CO3: Awareness on types and working of fuel cells.
CO4: Understanding how to establish a relationship with industries by excercising applied science

Unit 1 Background Theory

Origin of potential - electrical double layer - reversible electrode potential - standard hydrogen electrode - emf series - measurement of potential - reference electrodes (calomel and silver/silver chloride) indicator and ion selective electrodes - Nernst equation - irreversible processes - kinetic treatment - Butler-Volmer equation - overpotential, activation, concentration and IR overpotential - its practical significance - Tafel equation and Tafel plots - exchange current density and transfer coefficients.

Unit 2 Batteries: Primary Batteries

The chemistry, fabrication and performance aspects, packing classification and rating of the following batteries: (The materials taken, their function and significance, reactions with equations, their performance in terms of discharge, capacity, and energy density to be dealt with). Zinc-carbon (Leclanche type), zinc alkaline (Duracell), zinc/air batteries; Lithium primary cells - liquid cathode, solid cathode and lithium- ferrous sulphide cells (comparative account).

Unit 3 Secondary Batteries

Lead acid and VRLA (valve regulated (sealed) lead acid), nickel-cadmium, nickel-zinc, nickel-metal hydride batteries, lithium-ion batteries, ultrathin lithium polymer cells (comparative account). Advanced batteries for electric vehicles, requirements of the battery - sodium-beta and redox batteries.

Unit 4 Fuel Cells

Description, working, principle, anodic, cathodic and cell reactions, fabrication of electrodes and other components, applications, advantages, disadvantages and environmental aspects of the following types of fuel cells: proton exchange membrane fuel cells, alkaline fuel cells, phosphoric acid, solid oxide, molten carbonate, direct methanol fuel cells. Membranes for fuel cells: Nafion – Polymer blends and composite membranes; assessment of performance – recent developments.

Unit 5 Fuels for Fuel Cells

Hydrogen, methane, methanol - sources and preparation, reformation processes for hydrogen – clean up and storage of the fuels – use in cells, advantages and disadvantages of using hydrogen as fuel.

TEXTBOOKS

1. Dell, Ronald M Rand, David AJ, 'Understanding Batteries', Royal Society of Chemistry, (2001).
2. M. Aulice Scibioh and B. Viswanathan 'Fuel Cells – principles and applications', University Press, India (2006).

REFERENCES

1. Kanani N, 'Electroplating and electroless plating of copper and its alloy', ASM International, Metals Park, OH and Metal Finishing Publications, Stevenage, UK (2003).
2. Curtis, 'Electroforming', London, (2004).
3. F. Barbir, 'PEM fuel cells: theory and practice', Elsevier, Burlington, MA, (2005).
4. G. Hoogers, 'Fuel cell handbook', CRC, Boca Raton, FL, (2003).

25CHY372 Corrosion Science 3 0 0 3

Course Objective: To introduce the students to the underlying science of corrosion, thermodynamic and kinetic principles, mass transfer and potential theory, the causes, mechanism and prevention methods of various types of corrosion, its measurement and combating methods.

Course outcomes

On completion of the course the student will be able to

CO1: Understand the fundamentals of corrosion reactions and their mechanism

CO2: Identify the forms of corrosion

CO3: Evaluate corrosion rate and passivation potential

CO4: Provide methods for protection of materials

CO5: Select a suitable material for a specific application

Unit 1 Introduction to Corrosion

Mechanisms of Chemical corrosion, electrochemical corrosion, concentration cell corrosion, pitting corrosion, intergranular corrosion, waterline corrosion, stress corrosion.

Unit 2 Cathodic Protection

Basis of cathodic protection, working of cathodic protection, electrochemical theory of cathodic protection, design parameters in cathodic protection, cathodic protection interferences.

Unit 3 Corrosion Kinetics

Faradays laws of electrolysis and its application in determining corrosion rates, the laws, corrosion kinetics, mixed potential theory and its application, resistance polarization, determination of corrosion rates by electrochemical measurements, kinetics of passivity.

Unit 4 Corrosion Prevention by Design

Corrosive environment, stages in design processes, soldering and threading, crevices, flowing water systems, design for liquid containers, design in packaging, coating and design, storage of combat vehicles.

Unit 5 Selection of Materials for Corrosive Environment

Factors affecting the performance of materials, materials classification, materials and fluid corrosivity, corrosion behaviour of several materials.

TEXTBOOKS

1. Mars G. Fontana, 'Corrosion Engineering', 3rd edition, Tata McGraw-Hill, 2005.
2. P.E. Philip A. Schweitzer, 'Corrosion Engineering Handbook', 2nd edition, Inco alloys International, 1996.

REFERENCES

1. R. Winston Revie and Herbert H Uhlig, 'Corrosion and Corrosion Control', 4th edition, John Wiley & Sons, 2008.
2. Zaki Ahmad, 'Principles of Corrosion Engineering and corrosion', 3rd edition John Wiley & Sons, 2006.

25CHY373 Green Chemistry 3 0 0 3

Course Outcomes

On successful completion of this course, a student will be able to

CO1: Develop fundamental understanding of the principles of Green Chemistry and a quantitative estimation of greenness of a chemical reaction through sustainability metrices.

CO2: Understand the alternate solvents systems and green solvents available for application in industrial reactions.

CO3: Analyze industrial catalytic processes regarding sustainability.

Unit 1 Introduction to Green Chemistry

Introduction - inception and evolution of green chemistry - principles of green chemistry - the green chemistry expert systems - the measure of greenness - safety and risk indices - the hierarchical approach - green chemistry and sustainable development - pollution control to pollution prevention - Indian perspective on green chemistry - information technology and sustainable development.

Unit 2 Green Reagents

Green reagents - safer solvents - green solvents - water as a solvent - solvent free conditions - support reagents - ionic liquids and their applications - super critical systems (CO2) as green

solvents - hydrogen peroxide in green oxidation reactions - dimethyl carbonate, a green solvent and an ambient reagent.

Unit 3 Green Chemical Techniques I

Environmentally benign technologies by green chemistry (with examples) - microwave assisted synthesis-electro-organic synthesis - photochemical degradation as a green approach for waste treatment - catalysis and green chemistry - supported catalysts and reagents for green chemistry - heterogenized reactions for green chemistry - oxidation technology for waste water treatment - green chemistry using biocatalytic reactions.

Unit 4 Green Chemical Techniques II

Aqueous phase reactions, solid state reactions, enzymatic transformations, sonicated reactions - usual organic reactions (Benzoin condensation, Michael Addition, Heck Reaction, Darzen reaction, Heck reaction, Claisen arrangement) in a greener way.

Unit 5 Green Industrial Processes and Operations

Cleaner production - industrial perspectives - reactions and reactor designs - micromixers - unit operations - reactions with separation processes alternate energy resources - inherent safety - green chemistry and industries - the pharmaceutical industries and green chemistry - the polymer industry - pesticides, antifoulants, and herbicides - solvents and green chemistry - the food and flavor industry - the maleic anhydride manufacturing process - chelants - the surfactant industry - industries in need of support to go green - the semiconductor manufacture industry - the dye industry - the textile industry - the tannery industry - the sugar and distillery industries - the paper and pulp industry - the paint industry - Green chemistry in future.

TEXTBOOKS

1. Mukesh Doble and Anilkumar Kruthiventi, ‘Green Chemistry and Processes’, reprint, Science Press, 2007.

2. Paul T. Anastas and Tracy C. Williamson, ‘Green chemistry: frontiers in benign chemical syntheses and processes’, Oxford University Press, 1998.

REFERENCES

1. V. K. Ahluwalia, ‘Green Chemistry - Environmentally Benign Reactions’, 1st edition, Ane Books Pvt Ltd, 2009.

2. M. M. Srivastava, Rashmi Sanghi, ‘Green Chemistry - Environment Friendly Alternatives’, 2nd edition, Narosa Publishing House, 2005.

25CHY374 Industrial Catalysis 3 0 0 3

Course Objective: To impart basic knowledge on different types of catalysts and their industrial application.

Course Outcome:

CO1: To develop knowledge on chemical aspects of catalysis

CO2: Able to understand the different classification of catalysts

CO3: To understand the importance and preparative methods industrial catalysis process

Skills: To provide beginner knowledge in new chemistry of catalysis and its application in industry.

Unit 1 Catalysis

An introduction, general principles of catalysis, activation energy plots for catalytic processes, classification for catalysis - heterogeneous and homogeneous catalysis, van't-Hoff's and Arrhenius treatment of homogeneous catalysis - kinetic aspects, adsorption and general principles of heterogeneous catalysis - kinetic aspects, determination of surface area and pore-structure of the catalyst, definition of performance criteria of catalysts, activity, selectivity, temperature response, catalyst life.

Unit 2 Catalysis in Solutions

Acid and base catalysis, catalysis in gas phase, catalysis in dilute aqueous solutions, catalysis in concentrated strong acid solutions, catalysis by bases, catalysis by metal ions, electron transfer catalysis, catalysis by co-ordination and organometallic compounds, catalysis in Ziegler-Natta, metallocene, metathesis, catalysis by enzymes.

Unit 3 Polymers and Zeolites in Catalysis

Catalysis by polymers, polymer supported catalysts, catalysis in polymer gels, phase transfer catalysis, catalysis in molecular scale cavities, zeolites - molecular sieves, shape selective and size selective catalysis

Unit 4 Catalysis by Metals, Metal Oxides and Supported Metals

Electronic factors in catalysis by metals, valence bond and electron band theories, electronic factors in catalysis by semiconductors, co-operative electronics interactions and catalysis, localized interactions and catalysis, surface states and catalysis, role of supports, preparation and structure of supports, silica, alumina, silica-alumina, carbon, monolithic supports, surface properties, catalyst manufacture, catalyst size and shape, pre-treatments, deactivation processes, sintering, poisoning and catalyst fouling.

Unit 5 Industrially Important Catalytic Processes

Catalysis and green chemistry, catalysis by ionic liquids, catalytic reforming, catalytic cracking, hydrotreatment, steam cracking, Fisher Tropsch process, mobile process for conversion of methanol to gasoline hydrocarbons, catalysis for environmental protection, removal of pollutants

from exhausts, mobile and static sources, effluent clean up analysis, applications in the production of fertilizers, acetic acid, formaldehyde, washing powder additives, pharmaceuticals.

TEXTBOOKS

1. Bruce G Gates, 'Catalytic Chemistry', John Wiley & Sons, 1992.
2. J. A. Jensen, K. B. Rider, Y. Chen, M. Salmeron and G. A. Somorjai and E. K. Rideal, 'Concepts in Catalysis', Academic Press, New York, 1968.
3. Alfred Clark, 'The Theory of Adsorption and Catalysis', Academic Press, 1970.

REFERENCES

1. W.B. Innes, 'Experimental Methods in Catalytic Research', Volume 1, R.B. Anderson Academic Press, 1968.
2. J.M. Betty, 'Applied Industrial Catalysis', Volume 1, Academic Press, 1983.
3. Ronald Pearce, William R. Patterson, 'Catalysts and Chemical Processes', Wiley, 1981.
4. Michael Bowker, 'The Basis and Applications of Heterogeneous Catalysis', Oxford University Press, 1998.
5. J.C. Kuriakose, 'Catalysis', Macmillan India LTD, 1991.
6. Calvin H. Bartholomew and Robert J. Farrauto, "Fundamentals of Industrial Catalysis"

25CHY375 Introduction to Food Chemistry 3 0 0 3

Course Outcome:

CO1: Understand major and minor foods and their physical states.
CO2: Enlist the properties of water and its role in food system.
CO3: Understand the properties of Carbohydrates and proteins and its role in food system.
CO4: Comprehend the properties of Lipids, Vitamins and Minerals and its role in food system.
CO5: Ability to describe the basic properties and functions of enzymes, pigments, food additives its role in food system.
Skills: To provide an understanding of the chemical interactions of food components and their effects on sensory and nutritional quality, functional properties, and safety of foods

Unit 1 Introduction

Definition of food, major components of food, physical states of food – dispersions, true solutions, colloidal, emulsions, foam and gel, factors affecting stable dispersion of food ingredients, functions of emulsifiers and stabilizers. Water - functions of water in food systems, hydrogen bonds, permanent dipole moment dielectric constant, theories of solvent action, water activity and food stability, absorption isotherm curve, roles of water in physical properties and chemical reactions in food theories and applications of different moisture determination methods.

Unit 2 Proteins and Carbohydrates

Protein - Classifications, nomenclature, and structures of aminoacids, basic properties of protein, structure of proteins, protein functional groups and their chemical, hydrophobic, and hydrophobic properties, isoelelctric point and solubility as a function of pH, protein denaturation and its effects

on food systems, nutritional quality of protein, theories & applications of analytical methods for protein and amino acids determination.

Carbohydrates - Classification, nomenclature, and structures of Carbohydrates, isomers and absolute configurations of Carbohydrates, physical – chemical properties of Carbohydrates, sweetness of Carbohydrates, functions of Carbohydrates in foods, chemical reactions of Carbohydrates, analytical methods for Carbohydrate determination.

Unit 3 Lipids and minerals

Lipids - Nomenclature and structures of fatty acids, classifications of lipids, physical and chemical characteristics of different fats, relationship between chemical structure and fat melting properties, analytical methods for determining different physical and chemical characteristics of fat, lipid oxidation mechanisms, principles and applications of analytical methods for the determination of fat content and fatty acid composotions of foods.

Minerals - Ash determination methods, principles and applications of different methods for determining individual minerals – atomic absorption and flame spectrometry's, and chemical methods.

Unit 4 Vitamins

Water soluble and fat soluble vitamins, chemical reactions and losses of vitamins during processing and storage. Principles and techniques for the determination.

Unit 5

Pigments in food flavours, browing reaction in foods, enzymes in foods, and food industry, bio-deterioration of foods, food contaminants, food additives and toxin.

REFERENCE

1. Fennema's Food Chemistry fourth edition, edited by S. Damodaran, K.L. Parkin, and O.R Fennema, 2007 published by CRC Press .

SUGGESTED READINGS

1. Aurand, L.W. and Woods, A.E. 1973. Food Chemistry. AVI, Westport
2. Birch, G.G., Cameron, A.G. and Spencer, M.1986. Food Science, 3rd ED.Pergamon Press, New york.
3. Fennema O.R. Ed. 1976. Principles of Food Science: Part – I Food Chemistry. Marcel Dekker, New york.
4. Meyer, L.H. 1973. Food Chemistry. East – West Press Pvt. Ltd., New Delhi.
5. Potter, N.N. 1978. Food Science. 3rd Ed. AVI, Westport

25CHY376 Polymer Chemistry 3 0 0 3

Unit 1 Introduction to Polymers and Polymerization

History of polymer Science. Concept of macromolecules, nomenclature and classification. Polymer, monomer, oligomer, repeating unit, degree of polymerization, functionality, copolymer - random, alternating, graft, block, tacticity. polymerization processes. Free radical addition polymerization- kinetics and mechanism. Chain transfer. Mayo-walling equation of the steady state. Molecular weight distribution and molecular weight control. Radical atom transfer and. fragmentation – addition mechanism. Free radical living polymers. Cationic and anionic polymerization. Kinetics and mechanism, polymerization without termination. Living polymers. Step Growth polymerization- kinetics and mechanism. Molecular weight distribution. Linear vs cyclic polymerization, other modes of polymerization. Group Transfer, metathesis and ring opening polymerization. Copolymerization. The copolymerization equation, Q-e scheme, gelation and cross linking. Copolymer composition drifts, polymerization techniques - bulk solution, melt, suspension, emulsion, and dispersion techniques.

Unit 2 Polymer Stereochemistry and Characterization

Organizational features of polymer chains. Configuration and conformation, tacticity, repeating units with more than one asymmetric center. Chiral polymers - main chain and side chain. Stereo regular polymers. Manipulation of polymerization processes. Zeigler-Natta and Kaminsky routes. Coordination polymerization. Metallocene and metal oxide catalysts. Polymer characterization. Molecular weights. Concept of average molecular weights, Molecular weight distribution. Methods for determining molecular weights. Static and dynamic methods, light scattering and GPC. Crystalline and amorphous states. Glassy and rubbery states. Glass transition and crystalline melting. Spherulites and lamellar. Degree of crystallinity, X-ray diffraction, thermal analysis of polymers. TG/DTG, DTA/DSC, DMA/TMA/DMTA. Spectroscopy of polymers. Microstructure determination by IR, Raman, UV, NMR and MS techniques. Solid state NMR and polymer stereochemistry. Structure-property relationship. Elastomeric and viscoelastic states. Rubber-like elasticity. Maxwell and kinetic model of viscoelasticity.

Unit 3 Polymer Solutions

Treatment of dilute solution data. Thermodynamics. Flory-Huggin’s equation. Chain dimension - chain stiffness - end-to-end distance. Conformation-random coil, solvation and swelling. Flory-Reiner equation. Determination of degree of cross linking and molecular weight between crosslinks. Polymer structure - property relationship, crystalline and amorphous combinations.

Unit 4 Polymer Additives, Blends and Composites

Introduction - general principles, use of additives to enhance and protect properties of polymer, classes of polymer additives - type, structure, chemistry, mechanism and suitability: for antioxidant-heat stabilizers - UV stabilizers - HAL-antistatic - blowing agents - lubricants nucleating agents - cross linking agent - flame retardant-compatibiliser. Fillers - effect and type of fillers - surface treatment and coupling agent. Coloration of polymers – pigment - colour

measurement. Plasticizer – function - mode of operation - types. Compounding - main types of colorants – equipments - internal mixer, two roll mill, Banbury mixer, single screw extruder, twin screw extruder - co rotating - counter rotating - intermeshing. Fabrication methods, polymer blends, toughened plastics and phase separated blends, interpenetrating network, mechanical properties, composite fabrication.

Unit 5 Industrial and Speciality Polymers

Synthesis, structure and applications of polyethylene, polypropylene, polystyrene. Homo and copolymers. Diene rubbers. Vinyl and acrylic polymers. PVC, PVA, PAN, PA. poly (vinyl carbazole), poly (vinyl imidazole). PMMA and related polymers. Copolymers. EVA polymers. Fluorine containing polymers. Polyacetals. Reaction polymers. Polyamides, polyesters. epoxides, polyurethanes, polycarbonates, phenolics, PEEK, silicone polymers. Reactions of polymers. Polymers as aids in Organic synthesis. Polymeric reagents, catalysts, substrates, liquid crystalline polymers. Main chain and side chain liquid crystalline polymers. Phase morphology. Conducting polymers. Polymers with high bandwidth. Polyanilines, polypyrrols, polythiophenes, poly (vinylene phenylene). Photoresponsive and photorefractive polymers. Polymers in optical lithography. Polymer photo resists. Electrical properties of polymers, polymers with NLO properties, second and third harmonic generation, and wave guide devises.

TEXTBOOKS

1. F.W. Billmayer, 'Textbook of Polymer Science', 3rd Edition, Wiley. N.Y. 1991.
2. J.M.G Cowie, 'Polymers: Physics and Chemistry of Modern Materials', 2nd edition, Blackie Academic and professional, 1991.
3. P.J. Flory, 'Principles of polymer chemistry', reprint, Cornell University Press, 1953.

REFERENCES

1. F. Ullrich, 'Industrial Polymers', Kluwer, N.Y. 1993.
2. H.G. Elias, 'Macromolecules, Vol. I & II', Academic, 1991.
3. Harry A Allcock, Frederick W Lampe and James E Mark, 'Contemporary Polymer Chemistry', 3rd edition, Pearson Prentice Hall, 2003.

25CHY377 Surface Science and Coating Technology 3 0 0 3

Unit 1 Introduction to Paints and Paint Technology

General introduction to paint industry - definition of paints, varnishes and lacquers their constitution and functions, general classification of surface coatings - decorative and protective coatings - paint industries in India.

Unit 2 Pigments Dyes and Extenders

Definition and classification of pigments and dyes - properties and evaluation of pigments such as crystal structure particle size and shape, refractive index and hiding power, oil absorption, colour, specific gravity and bulking value, UV and IR absorption, light fastness, resistance to heat water, alkali and acid, corrosion inhibition, toxicity, reducing power, tinting strength, flooding and

floating, settling, volatile and water soluble matter, residue on sieve, bleeding - white pigments and coloured pigments - organic and inorganic pigments - industrial manufacture of pigments - special effect pigments - Extenders - use and functions of extenders - examples for extenders.

Unit 3 Binding Media, Solvents and Additives in Paints

Fundamentals of film formers, chemical structure of monomers, functionality and its determination, degree of polymerization and molecular weight, non-convertible and convertible film formers, linear, branched and cross linked film formers, homopolymers and copolymers - manufacture, chemistry and applications of alkyd resins, polyester resins, phenolic resins, amino resins, epoxy resins, polyamide resins, polyurethanes, silicone resins, vinyl and acrylic resins - emulsions - polystyrene and styrene-acrylic emulsions. Solvents, dryers, surfactants and other additives in paints.

Unit 4 Paint Formulation, Manufacture and Application Techniques

Principles of paint formulation, formulation elements, mathematics & steps: PVC, CM, P/B ratio, sp gravity, etc; typical formulations of primers, undercoats and finish coats - steps in paint manufacturing, phenomenon of wetting, grinding and dispersion, important considerations in pigment dispersion and rheology - different milling and mixing techniques - factors affecting effectiveness of milling such as size, speed and type of mill; volume, composition, size and shape of grinding medium - mill base. Surface preparation techniques - physical and chemical surface treatment techniques - common application techniques - packaging technology.

Unit 5 Colour Technology, Paint Properties and Quality Control in Paint Industries

Colour science and technology - light spectrum, primary and complementary colours, colour mixing, dimensions of colour and colour systems, colour measurements, computer colour matching - colour coding system - general properties of paints, classification of paint properties - adhesion and cohesion properties, factors affecting adhesion wetting power, optical properties; colour, gloss, hiding, etc., physical, chemical and mechanical properties of paint films - factors affecting coating properties - rheological properties - Newtonian and non-Newtonian liquids, thixotropy, factors affecting viscosity, objectives of paint testing - quality control procedures, standard specifications and test methods - tests on liquid paints density, dispersion, viscosity and consistency, wet opacity and dry hiding, spreading capacity and spreading rim, wet and dry rim thickness, drying time, etc. - tests of dried coatings, colour and colour fastness, light fastness, gloss, flexibility, adhesion impact test, hardness mar resistance, abrasion resistance water and moisture resistance; water vapour transmission, PAC and salt spray test resistance, resistance to chemicals and solvents, resistance to heat and fire, air permeability - evaluation of water based paints, biological effects on paint films. Analysis of paints and varnishes; volatile and nonvolatile matter pigment content, binder or solid vehicle content, water content, ash content, pigment binder and solvent analysis - ageing properties of coatings, weatherometery, natural outdoor durability test, accelerated outdoor weathering, artificial weathering tests, defects observed in paint film on exposure.

TEXTBOOKS

1. Australian OCCA, 'Surface Coating Technology Volume 1', Chapman and Hall, 1974.
2. W. M. Morgan, 'Outline of Paint Technology', John Wiley Sons, 1990.

REFERENCES

1. L. S. Pratt, 'Physics & Chemistry of Organic Pigments', Wiley, 1947.
2. H.Y. Payne, 'Organic Coating Technology Vol, 1 & 11', John Wiley & Sons, 1954.

25CHY378 Forensic Science 3 0 0 3

Unit 1 Introduction

Origin of forensic science, need for forensic science, trace and contact evidence, marks and impression, examination of documents, blood stain analysis, microscope in analysis, explosives, chemical analysis of explosives, forensic laboratories and courses in India.

Unit 2 Narcotics

Narcotics, classification of drugs, specific drugs- Psychotropic drugs, chemical screening of drugs, chemical extraction and sample preparation, chemical identification of drugs using analytical methods.

Unit 3 Fingerprinting and Firearm Analysis

History of fingerprinting, principles of fingerprinting, constituents of latent finger marks, fingerprint detection, chemical methods of detection, firearm examination, chemical analysis of firearm, analysis of gunshot residue.

Unit 4 Toxicology

Introduction to Toxicology, alcohol and human body, testing of blood alcohol concentration, toxins & biological poisons, measuring toxicity as LD50, sample and analysis, inorganic poisons, nerve agents, radioactive toxins, pharmacokinetics and toxicokinetics, tests for toxins, reported case studies.

Unit 5 Post-mortem Toxicology

Introduction, tissue and fluid specimens, specimen collection and storage, extraction procedure, analytical techniques, interpretation, case studies

REFERENCE

1. Lawrence Kobilinsky, Forensic Chemistry Handbook, John Wiley & Sons, New Jersey, 2012
2. David E. Newton, Forensic Chemistry, Facts On File, Inc, New York, 2007
3. Jay A. Siegel, Forensic Chemistry fundamentals and applications, Wiley Balckwell.
4. Suzanne Bell, Drugs, Poisons, and Chemistry, Facts On File, Inc. New York, 2009.

❖ List of Elective PG Papers:

25CHY631 Applied Electrochemistry 3 0 0 3

Unit 1 Electrodics: Electron transfer under an interfacial electric field, A two-way traffic across the interference: equilibrium and exchange current density. Dependence of the electrochemical reaction rate onoverpotential - quantitative version of the Butler Volmer equation. Electrode kinetics involving the semiconductor/solution interface. Techniques of electrode kinetics - preparation of electrode surface. Microelectrodes - applications

Unit 2 Industrial Cathodic Process - Electrodeposition of copper, nickel and chromium over mild steel –zinc plating on MS – decorative plating of silver and cold – nano plating and microstructure of deposits - Tests for adhesion, hardness, thickness, uniformity and corrosion resistance of the electro deposits - post plating passivation processes - barrel plating of small components - Electroless deposition of nickel, copper,gold on metal components – making of waveguides and plated through hole boards -

Unit 3 Industrial Anodic Processes: Anodizing of aluminium and its alloys – baths used, operating conditions and sequence determination of thickness – industrial applications - nano anodizing of titanium,and tantalum – application to sensor field - Electropolishing of ferrous and non-ferrous metals and alloys -mechanism of electropolishing –Electrochemical etching of ferrous and non-ferrous metals – Special processes: Electrolysis of water – electrowinning of aluminium and sodium – electrolysis of brine- photoelectrochemistry

Unit4 Electrochemical Energy Systems: Primary batteries: Zinc-carbon (Leclanche type), zinc alkaline (Duracell),; lithium primary cells - liquid cathode, solid cathode and lithium-ferrous sulphide cellsSecondary batteries: Lead acid and VRLA (valve regulated [sealed] lead acid), nickel-cadmium, nickel- zinc, nickel-metal hydride batteries, lithium ion batteries, ultra-thin lithium polymer cells (comparative account) Advanced Batteries for electric vehicles, requirements of the battery - sodium-beta and redox batteries. Reserve batteries, thermally activated batteries - remote activation - pyrotechnic materials: FuelCells: principle, proton-exchange membrane (PEM), direct methanol (DMFC), molten carbonate electrolyte (MCFC) fuel cells and outline of biochemical fuel cells.

Unit5 Electrochemical Sensors: Potentiometric sensors, solid state potentiometric chemical sensors, polymeric membrane sensors, ion selective field effect transistor, application, hydrovolumetric technique- hydrodynamic voltammetric-application, voltammetric sensors-electrode modification application, optical sensors - bioamperometric titration. Methods involving forced convection - hydrodynamic methods

Text books

1. *Allen J. Bard and Larry R. Faulkner, 'Text book for Electrochemical Methods',2nd edition, Wiley, 2000.*
2. *Derek Pletcher and Frank C. Walsh, 'Industrial Electrochemistry', Blackie Academic and Professional,(1993).*

References

1. *Christopher M A, Brett, 'Electrochemistry – Principles, Methods and Applications', Oxford University,(2004).*
2. *Watanabe T, 'Nano-plating: microstructure control theory of plated film and data base of plated filmmicrostructure', Elsevier, Oxford, UK (2004).*
3. *Kanani N, 'Electroplating and electroless plating of copper and its alloy', ASM International, MetalsPark, OH and Metal Finishing Publications, Stevenage, UK (2003).*
4. *Curtis, 'Electroforming', London, (2004).*
5. *Rumyantsev E and Davydov A, 'Electrochemical machining of metals', Mir, Moscow, (1989).*
6. *Peter G Sheasby 'Basics of Aluminium Anodizing', Banbury, Oxon (2001)*
7. *Robert Brugger 'Nickel Plating' Robert Draper Ltd, Teddington, (1970)*
8. *J. K. Dennis, T. E. Such, 'Nickel and Chromium Plating, Third Edition' Woodhead Publishing Series in Metals and Surface Engineering, 3rd Edition, (1993)*

25CHY632 Bioanalytical Chemistry 3 0 0 3

Unit 1 Enzymes

Enzyme nomenclature, enzyme commission numbers, enzymes in bioanalytical chemistry, enzyme kinetics

- enzyme activators, enzyme inhibitors.

Unit 2 Quantification of Enzymes and Their Substrates

Instrumental methods, optical detection - absorbance, fluorescence, luminescence, nephelometry electrochemical detection - amperometry, potentiometry, conductometry, other detection methods - radiochemical, manometry, calorimetry.

Unit 3 Immobilized Enzymes

Immobilization methods - nanopolymerizing covalent immobilization, Crosslinking with bifunctional reagents. Properties of immobilized enzymes, immobilized enzyme reactions, theoretical treatment of packed bed enzyme reactors.

Unit 4 Antibodies

Structural and functional properties of antibodies, Polyclonal and monoclonal antibodies Antibody-antigeninteractions, analytical application of secondary antibody-antigen.

Unit 5 Biosensors

Response of enzyme-based biosensors, examples of biosensor configuration, ferrocene-mediated amperometric glucose sensor, potentiometric biosensor for phenyl acetate, potentiometric immunosensor for digoxin, optical biosensor for glucose based on fluorescence energy transfer, piezoelectric sensor for nucleic acid detection, enzyme thermistors.

TEXTBOOKS

1. *Susan R. Mikkelsen, and Eduardo Corto´n 'Bioanalytical Chemistry', 1st edition, Wiley Interscience, 2003.*
2. *Andres Manz, Nicole Pamme and Dimitri Lossifidis, 'Bioanalytical Chemistry', World*

Scientific Publishing Company, 2004.

REFERENCE

1. *Robert W. Cattrall, 'Chemical Sensors', Oxford University Press, 1997.*

25CHY633 Chemistry of Biomolecules 3 0 0 3

Unit 1 Amino acids, Proteins and Peptides

Classification, Stereochemical aspects, physical properties, Ionic properties, spectral properties, essential and non-essential amino acids, chemical reactions of amino acids, Industrial preparation and chemical synthesis of amino acids. Ionic properties of proteins, protein structure, protein purification, protein structure determination, proteomics and protein function, solid phase peptide synthesis, biologicallyimportant peptides.

Unit 2 Enzymes

Introduction to Enzymes, Classification of enzymes, mechanism of enzyme action, immobilized enzymes and enzyme technology, enzyme- analogue built polymers, design of molecular clefts, enzymes in syntheticorganic chemistry. Enzymes in biological systems

Unit 3 Molecular Biology and Bioinformatics

Structure of nucleic acids, genes and genome complexity, functions of nucleic acids, isolation and separation of nucleic acids, molecular analysis of nucleic acid sequences, nucleotide sequencing of DNA.

Unit 4 Immunochemical Techniques

Production of antibodies, purification and fragmentation of immunoglobulins, immunoprecipitation, labelling antibodies, immunoblotting, immunoassays, immunohistochemistry/cytochemistry.

Unit 5 Recombinant DNA and Genetic Analysis

Constructing gene libraries, cloning vectors, hybridization and gene probes, application of gene cloning, expression of foreign genes, pharmacogenomics.

REFERENCES

1. *Hermann Dugas, 'Bioorganic Chemistry - A Chemical Approach to Enzyme Action', 3rd edition, Springer.*
2. *Keith Wilson and John Walker, 'Principles and Techniques of Biochemistry and Molecular Biology', 6th edition, Cambridge University Press.*

25CHY634 Industrial Chemistry 3 0 0 3

Unit 1 Water Treatment

Softening of water, ion exchange process, lime soda process, modified lime soda process, zeolite process, chemical and physical method of sterilization, desalination, boiler problems. Corrosion of boiler units, industrial water treatment, water analysis.

Unit 2 Fuels

Calorific value, determination of calorific value, classification of fuels, solid fuels, properties of fuels, classification of coal, coking and non-coking coals, advantages and disadvantages of solid fuels. Liquid fuels, gaseous fuels, analysis of fuel gases, distillation of petroleum. processing & purification of petroleumand petroleum products, flash point, fire point, knocking, antiknocking, cetane number, octane number, natural gasoline, cracking, polymerization, alkylation, isomerisation, rocket fuels, fossil fuels, nuclear fuels.

Unit 3 Energy Resources

Renewable and non-renewable sources of energy, conventional and non-conventional sources of energy, solar energy, solar technology, solar photovoltaic cell - application, PV lantern system, radiotelephonesystem, application of solar energy, environmental implication, nuclear energy, nuclear fuel cycle in India,Energy conservation and waste heat boilers, Fuel cells, hydrogen cells.

Unit 4 Paints and Pigments

White pigment, blue, green, yellow, black and red pigments - manufacture, physical properties, characteristics, manufacture of paints, setting of paints, requirement for good paints, emulsion paint, latexpaint, luminescent paint, fire retardant paints, heat resistant paints, varnishes, manufacture of varnishes, enamels, lacquers.

Unit 5 Explosives and Toxic Chemical Weapons

Introduction, classification. deflagrating or low explosives. Characteristics of explosives, nitrocellulose, PETN, DNB, TNB, TNT, picric acid, nitro glycerine, dynamite, cirdite, gun powder, RDX, EDNA, HMX, tetryl, pentyl, hexyl, dinol. toxic chemical weapons, screening smokes, incendiaries, pyrotechniques, explosives in India.

TEXTBOOKS

1. *B.K. Sharma, 'Industrial Chemistry', Goel publishing.*
2. *James A Kent, 'Riegel's Hand book of Industrial chemistry', 10th edition, Kluwer Academic/Plenum publishers, 2003.*

REFERENCES

1. *Alan Heaton, 'An Introduction to Industrial chemistry', 3rd edition, Blackie Academic and professional,1996.*
2. *Chris A Clausen and Guy Mattson, 'Principles of industrial chemistry', 2nd edition Wiley, 1978.*
3. *Jonathan Steed, 'Core Concepts on supramolecular chemistry and nanochemistry', Wiley Eastern Publishers, 2006.*

25CHY635 Industrial Stoichiometry 3 0 0 3

Unit 1 Introduction to process calculation - dimensions and systems of units - fundamental quantities of units, derived quantities, definition and units of force, volume, pressure, work, energy, power, heat-unit conversions in FPS, MKS and SI systems.

Unit 2 Mixtures and solutions - methods of expressing compositions of mixture and solutions, wet and drybasis concept. Ideal and real gas laws – gas constant – normal molal volume, calculations of pressure, volume and temperature using ideal gas law. Gas mixtures – use of partial pressure and pure component volume in gas calculations. Dissociating gases. Relation between mole%, volume% and pressure% of idealgases, calculation of average molecular weight, density, mole%, weight% in gas mixture in SI/MKS systems – applications of real gas relationship in gas calculation.

Unit 3 Description and simple material balance calculation of physical processes such as drying, distillation, absorption, mixing, crystallization, evaporation.

Unit 4 Single stage material balance calculation of leaching and extraction, calculations involving recycling and by-passing operation - limiting reactant, excess reactant, conversion, yield and selectivity - simple numerical for finding yield, conversion and composition.

Unit 5 Calculation of material and energy balance based on reactions involving heat capacity and specific heat - mean heat capacity of gases - heat capacity of gas mixture and liquid mixture. Calculations of heat capacity by integral equation up to three terms - sensible and latent heats of fusion, sublimation, vaporization. Calculations of standard heat of formation from heat of combustion data. Calculations for heat of reaction from heat of formation and heat of combustion data – fuels - calorific values proximate andultimate analysis - air requirement and composition of flue gases.

TEXTBOOKS

1. *Bhatt, B.L. Vora, S.M., "Stoichiometry", 3rd Edition, Tata McGraw-Hill (1996).*
2. *Felder, R.M. and Rousseau, R.R. "Elementary Principles of Chemical Processes" 3rd Edn., John Wiley& Sons, New York 2000.*

REFERENCES

1. *Hougen O.A., Watson K.M. and Ragatz R.A., "Chemical Process Principles" Part I, CBS Publishers (1973).*
2. *Warren. K Lewis, Arthur H. Radash & H. Clay Lewis, "Industrial Stoichiometry", McGraw Hill BookC., NY 1995.*

25CHY636 Material Science and Nanochemistry 3 0 0 3

Unit 1 Introduction to nanomaterials, introduction to material science, interdisciplinary nature, structure ofnanomaterials, length scales, de-Broglie wavelength & exciton Bohr radius, foundations of quantum mechanics: wave function, Schrödinger equation, uncertainty principle, quantum wells, quantum wires, quantum dots, articles.

Unit 2 Nanomaterials: Synthesis, properties, size effect and properties of nanoparticles - particle size - particle shape - particle density, specific surface area and pore - composite structure, crystal structure - functionality of nanostructures and their characteristic evaluation - optical properties - catalytic property; synthesis - methods and strategies, top-down and bottom-up approaches, chemical vapor deposition, laser ablation, electric-arc, sol-gel processing, lithography - surface modification of inorganic nanoparticles byorganic functional groups.

Unit 3 Surface science and characterization of nanomaterials. Electron Microscopy, MFM, SNOM, SEM,TEM, EDAX, X-ray diffraction and electron diffraction, atomic force microscopy, scanning tunneling microscopy, spectroscopy: UV-visible spectroscopy, photoluminescence spectroscopy, IR spectroscopy, FTIR and ATR, Raman spectroscopy, self-assembled monolayers.

Unit 4 Nanotechnology: applications and devices. Nanoscale materials, nano transfer printing, biomaterials applications, MEMS and NEMS, self-organization, nanoscale (opto) electronics, fullerenes, devices - actuators and motors for nano displacements, nanosensors, development of optical memory using semiconductor nanoparticles - nozzle-free inkjet technology - dendrimers and their application to organic electronics devices - nanomedicines, bio-imaging with quantum dots.

Unit 5 Environmental issues in nanotechnology. Nanoparticles and environment - nanoparticles in atmosphere - ground water, exhaust gases – waste water and indoor environments; safety of nanoparticles
- problems caused by nanoparticles, safety assessment for the nanoparticles; removal of nanoparticles.

TEXTBOOKS

1. *T. Pradeep, 'Nano - The Essentials Understanding Nanoscience and Technology', McGraw-HillProfessional Publishing, 2008.*
2. *Charles P. Pool and Frank J. Ovens, 'Introduction to Nanotechnology', John Wiley and sons, 2006.*

REFERENCES:

1. *Ozin, Geoffrey Alan, Arsenault, 'Nanochemistry: A Chemical Approach to Nanomaterials', RoyalSociety of Chemistry, 2008.*
2. *C.N.R. Rao, A. Muller, A.K. Cheetham, 'The Chemistry of Nanomaterials: Synthesis, Properties andApplications', Wiley-Vch Verlag Gmbh & Co., 2004.*
3. *Alexei Nabok, 'Organic and Inorganic Nanostructures', Artech House, 2005.*
4. *C. Richard Brundle, Charles A. Evans Jr., and Shaun Wilson, 'Encyclopedia of Materials Characterization', Butterworth-Heinemann Publishers, 1992.*
5. *Masuo Hosokawa, Kiyoshi Nogi, Makio Naito and Toyokazu Yokoyama, 'Nanoparticle TechnologyHandbook', Elsevier Publishers, 2007.*

25CHY637 Medicinal Chemistry 3 0 0 3

Unit 1 Medicinal chemistry: Introduction, drugs – classification of drugs – mechanism of drug action. Drug-receptor complex, nomenclature – agonist,

Unit 2 Physicochemical Properties of Drugs in Relation to Biological Action: solubility**,** partition coefficient, dissociation constant, hydrogen bonding, ionization, drug shape, surface activity, complexation,protein binding, molar refractivity, bioisosterism – stereo chemical aspects of drug action.

Enzymes, hormones and vitamins - representative cases, nomenclature, classification and characteristics ofenzymes, mechanism of enzyme action, factors affecting enzyme action, co-factors and co-enzymes, enzymes in organic synthesis, mechanism of enzyme catalysis, enzyme inhibition. Hormones and vitamins

– representative cases.

Unit 3 Essentials of Drug Design

Molecular mimetics, drug-lead modification, drug design using QSAR and computer assisted design, assessment of drug activity, receptors and drug action, mechanism of drug action, drug metabolism pathways, drug potentiation, drug antagonism and drug resistance

Unit 4 Medicinal Agents from Natural Products

History of the use of natural products as therapeutic agents, medicinal plants, active principle, isolation methods of alkaloids, terpenes, antioxidants, natural oils from plants

Unit 5 Medicinal Agents

Medicinal agents belonging to alkaloids, steroids, polypeptides, modified nucleic acid bases, sulphonamide and sulpha drugs, antibacterials - sulpha drugs, substituted sulphonamides, anticonvulsants, anticoagulants, antiamoebic agents, anthelmintic agents, anti-malarial agents, diuretics and cardio vascular agents, medicinal agents affecting CNS, analgesics, antipyretics, antiseptics and disinfectants, histamine and anti-histaminic agents. Infectious and non-infectious diseases (malaria, AIDS, Cancer) introduction, mechanismof action types of cure.

TEXTBOOKS

1. *John M beak and John H Block, 'T Wilson, O. Gisvold and R. F. Deorge - Text book of Organic, Medicinal and Pharmaceutical Chemistry', 7th edition, J.B. Lippincott Williams and Wilkons Company, 1977.*
2. *A. Burger, 'Medicinal Chemistry', 3rd edition, Wiley Interscience, 1970.*
3. *V.K. Ahluwalia and Madhu Chopra, 'Medicinal Chemistry', Ane Books Pvt. Ltd, 2008.*

REFERENCES

1. *V. Kothekar, 'Essentials of Drug Designing', 14th edition, Dhruv publications, 2005.*
2. *V.K. Ahluwalia, Lalita S. Kumar and Sanjiv Kumar, 'Chemistry of Natural Products', Ane Books India.*
3. *L.P. Graham 'An introduction to Medicinal Chemistry', 3rd edition, Oxford University Press, 2005*

25CHY638 Supramolecular Chemistry 3 0 0 3

Unit 1 Introduction to Supramolecular Chemistry

From molecular to supramolecular chemistry: factors leading to strong binding, hydrogen bonding and stacking interactions, bottom-up approach, top-down approach, energy and signals semiochemistry, photo switching devices, electro switching devices, mechanical switching processes,

Unit 2 Processing of Energy and Signals by Molecular and Supramolecular System

Fundamental principles of photo induced electron and energy transfer, molecular electronics, molecular photonics, molecular chemionics, molecular electro photonics, molecular photochemionics.

Unit 3 Molecular Recognition

Molecular receptors: crown ethers, siderophores, cyclophanes, cyclodextrin and their application in specificrecognition processes. Metal guided self-assembly reactions, molecular knot with double helical complexes, self-assembly of polynuclear metal complexes.

Unit 4 Electrochemistry of Supramolecular Systems

Electroluminescent systems as sensors and devices, Redox controlled molecular switches, biohybrid electrochemical devices, dendrimers as multielectron storage devices, redox-active Metal - Polypyridine dendrimers as light harvesting antennae.

Unit 5 Molecular Scale Mechanical Devices

Introduction to mechanical devices, spontaneous mechanical like motions, allosteric movements, tweezersand harpoons, a natural proton pump, twisters, tweezers, threading - dethreading movements, ring switchingprocesses in rotaxanes and catenanes, molecular valves, molecular muscles.

TEXTBOOKS

1. *Vincezo Balzani, 'Supramolecular Chemistry', Kluwer Academic, 1992*
2. *Vincenzo Balzani, Alberto Credi and Margherita Venturi, 'Molecular Devices and Machines: AJourney into the Nanoworld', Wiley, 2006.*
3. *Paola Ceroni, Alberto Credi and Margherita Venturi, 'Electrochemistry of Functional SupramolecularSystems', Wiley, 2010.*

REFERENCES

1. *Jonathan W. Steed Atwood, Jerry L. Chich, 'Supramolecular Chemistry', 2nd edition, Wiley, 2009.*
2. *Fritz Vögtle and F. Alfter 'Supramolecular Chemistry: An Introduction', John Wiley & Sons, 1999.*
3. *Jean-Marie Lehn, 'Supramolecular Chemistry', RCS pubs., 2005*
4. *Jonathan Steed, David Turner and Carl Wallace, 'Core concepts in Supramolecular Chemistry andnanochemistry', John Wiley & Sons, 2007*
5. *Katsuhiko Ariga and Toyoki Kunitake, 'Supramolecular chemistry – Fundamentals and applicationsadvanced textbook', Springer-Verlag, 2000*

25CHY639 Nanomaterials for Biomedical Applications 3 0 0 3

Unit 1 Introduction to nanomaterials: size dependence of properties – surface to volume ratio and quantumconfinement. Microscopic techniques to study nano structures - SEM, AFM – TEM and STM. Spectroscopic techniques to characterize nanostructures - Raman, XPS, Auger, EDAX.

Unit 2 Synthetic approaches: colloidal, self-assembly (self assembled monolayers-SAMs) and electrostatic self-assembly, electrochemical methods (cathodic and anodic processes), sol-gel, Langmuir-Blodgett (LB)technique, chemical vapour deposition, plasma arcing and ball milling, lithography.

Unit 3 Electrical, optical, mechanical, chemical and magnetic properties of nanomaterials. Surface Plasmonresonance – Fluorescence Resonance energy transfer (FRET).

Unit 4 Carbon clusters: synthesis, properties and biomedical applications of fullerenes, carbon nanotubes and graphenes. quantum dots, wells and wires (metallic and semiconducting) - preparation, properties andbiomedical applications. Dendrimeric structures and their applications.

Unit 5 Biofunctionalization of nanomaterials - noncovalent assembly - covalent assembly - biofunctional nanomaterials - semiconductor nanoparticles – magnetic nanoparticles. Applications of biofunctional nanomaterials – optical and electrochemical sensing.

REFERENCES

1. *Alexei Nabok, "Organic and Inorganic Nanostructures", Artech House, Inc., 2005*
2. *Huangxian Ju, Xueji Zhang and Joseph Wang, "Nano Biosensing, Principles, Development andApplication", Springer, 2011.*
3. *M. Reza Mozafari (Editor), "Nanomaterials and Nanosystems for Biomedical Applications", Springer2007.*
4. *Zhong Lin Wang (Editor), "Characterization of Nanophase Materials", Wiley VCH, 2000.*

25CHY640 Industrial Metal Finishing Processes 3 0 0 3

Unit 1 Background Theory: Review of reversible and irreversible processes - electrodes, indicator and reference - Nernst and Butler-Volmer equation - phenomenon of polarization - factors influencing - Tafel experiment and Tafel plot - Significance.

Unit 2 Electrodeposition: Industrial plating of copper-nickel (dull and bright) - chromium on mild steel –operating conditions and sequence – pre-treatment processes - plant layout – electroplating of zinc on MSand post plating, chromating, yellow and blue passivation processes – decorative plating of silver and goldon non-ferrous metals – brief discussion on nano plating of metals and micro structure of the deposition. Properties of deposits: tests for adhesion, hardness, thickness, uniformity and corrosion resistance of theelectro deposits.

Electroless deposition: nickel, copper, gold on metal components – bath composition and operating conditions - immersion plating - plating on plastics – pre-treatment processes – long duration plating – electroforming, operating conditions and sequence.

Unit 3 Anodizing: industrial anodizing of aluminium and its alloys – baths used, operating conditions andsequence – plant layout – effect of temperature and current density on the thickness of anodic film – determination of thickness – industrial applications.
Nano anodizing of titanium, aluminium and tantalum – application to sensor field.
Plasma electrolytic oxidation: power supply requirements – baths used – process sequence for aluminium,magnesium and titanium – properties of the coating and industrial applications.

Unit 4 Electropolishing: Mechanism of electropolishing – electropolishing of ferrous and non-ferrous metals – industrial baths used – operating conditions and sequence - industrial applications.

Unit 5 Electrochemical etching: etching of ferrous and non-ferrous metals – special properties of matt andsatin finish – DC and AC processes – operating conditions and sequence.
Special Topics: electrochemical and chemical metal colouring of ferrous and non-ferrous metals. Black nickel coating – hard chromium deposition – hard anodizing of aluminium – electrochemical machining ofhard steels – electro-winning process – Barrel plating – electrodeposition of paint.

TEXTBOOK

1. *Derek Pletcher and Frank C. Walsh, 'Industrial Electrochemistry', Blackie Academic andProfessional, (1993).*

REFERENCES

1. *Christopher M A, Brett, 'Electrochemistry – Principles, Methods and Applications', Oxford University,(2004).*
2. *Watanabe T, 'Nano-plating: microstructure control theory of plated film and data base of plated filmmicrostructure', Elsevier, Oxford, UK (2004).*
3. *Kanani N, 'Electroplating and electroless plating of copper and its alloy', ASM International, MetalsPark, OH and Metal Finishing Publications, Stevenage, UK (2003).*
4. *Curtis, 'Electroforming', London, (2004).*
5. *Rumyantsev E and Davydov A, 'Electrochemical machining of metals', Mir, Moscow, (1989).*
6. *Peter G Sheasby 'Basics of aluminium anodizing', Banbury, Oxon (2001)*
7. *Robert Brugger 'Nickel Plating' Robert Draper Ltd, Teddington, (1970)*
8. *J.K. Dennis, T.E. Such, 'Nickel and Chromium Plating, Third Edition' Woodhead Publishing Series inMetals and Surface Engineering, 3rd Edition, (1993)*

25CHY641 Biosensors: Fundamentals and Applications 3 0 0 3

Unit 1 Introduction to biosensor – classification based on the signal transduction and biorecognition element. Enzymatic and non-enzymatic sensors, DNA and protein-based sensors - immunosensors.

Unit 2 Biosensing using nanomaterials: concepts of surface to volume ratio, quantum confinement, surfaceplasmon resonance, fluorescence, chemiluminescence and electroluminescence and FRET in

biosensing. Application of metal, semiconducting quantum dots, carbon nanotubes, graphene and carbon dots in biosensing.

Unit 3 Electrochemical principle in biosensing: principles of potentiometry, voltammetry, amperometry and impedimentary in biosensing. Principle, fabrication and working of optical, electrochemical biosensors. Construction and working of potentiometric, amperometric and impedemetric sensors. Development and applications of piezoelectric sensors.

Unit 4 Optical and electrochemical sensors for glucose, vitamins, cholesterol, dopamine, nitric oxide, nitrates, and pesticides. Biocompatibility of sensors.

Unit 5 Biochips and wearable devices: lab-on-a-chip - fabrication of microfluidics- lithography, wearable sensors, epidermal electronic system, lab-on-skin-devices.

REFERENCES

1. *Xueji Zhang, Huangxian Ju, Joseph Wang, "Electrochemical Sensors, Biosensors and TheirBiomedical Applications", Elsevier, 2008*
2. *Joseph Wang, "Analytical Electrochemistry", Wiley, 2006*
3. *Huangxian Ju, Xueji Zhang, Joseph Wang, "Nano Biosensing: Principles, Development andApplication", Springer, 2011.*
4. *Peter Grundler, "Chemical Sensors – An Introduction for Scientists and Engineers", Springer-Verlag,Berlin Heidelberg, 2007*
5. *Arben Merkoci, "Biosensing using nanomaterials" Wiley, 2009.*

25CHY642 Computational Chemistry 3 0 0 3

Unit 1 Introduction

Introduction to computational chemistry (molecular modelling), questions commonly investigated computationally, principle and application of methods (tools) of computational chemistry - molecular mechanics, ab initio method, semiempirical methods, density functional theory and molecular dynamics, STOs, GTOs, basis sets, specification of molecular geometry using Cartesian coordinates and internal coordinates, Z-matrix, Z-matrix of simple molecules (water, ethanol), potential energy surface (PES), potential energy surface of diatomic molecules and triatomic molecules (H_2O and HOF) - hypersurface andprocess of "slicing", stationary points on a potential energy surface - potential energy surface of the isomerization reaction of ozone to isoozone, stationary points (ozone, isoozone and transition state), intrinsic reaction coordinate, minimum, relative minimum, saddle-shaped surface, saddle point, higher- order saddle point and mathematical treatment of stationary points, Born-Oppenheimer approximation andits significance and frozen-nuclei energy.

Unit 2 Molecular Mechanics

Introduction to molecular mechanics, forcefield, developing a force field - expression for potential

energyof a molecule, bond stretching term, angle bending term, torsional term and nonbonded interaction term, parameterizing a forcefield – parameterizing bond stretching term, angle bending term, torsional term andnonbonded interaction term, calculation using forcefield - compare the energies of two 2, 2, 3, 3-tetramethylbutane geometries, illustration of application (use) of molecular mechanics - calculation of geometries and energies of small-sized and medium-sized molecules, polymers and transition states (transition state for the Diels-Alder reaction of butadiene with ethene to form cyclohexene), in organic synthesis for predicting the more suitable path for carrying out the synthesis and calculation of normal- mode vibrational frequencies for characterizing a species as a minimum or a transition state or higher-ordersaddle point, for obtaining zero-point energies to correct frozen-nuclei energies and for interpreting or predicting IR spectra, strength (merit) and weakness (demerit) of molecular mechanics.

Unit 3 Semiempirical Methods - Part 1

Introduction to semiempirical (SE) methods, Simple Huckel Method (SHM) - theory - expression for calculating energy of a molecular species, expression for molecular wave function based on LCAO approximation, secular equations and the single matrix equation, H, C, S and ε matrices and theirinterpretation, the values of H_{ij} as zero, coulomb integral α and bond integral β and their physical significance, the H matrix in terms of α, β and zero for ethene system(ethene neutral molecule, ethene radical cation and ethene radical anion), propenyl system (propenyl cation, propenyl neutral radical and propenyl anion) and cyclobutadiene system (square cyclobutadiene dication, square cyclobutadiene neutralmolecule and square cyclobutadiene dianion), the H matrix in terms of zero, $\alpha = 0$ and $\beta = -1$for ethene systems (ethene neutral molecule, ethene radical cation and ethene radical anion), propenyl system(propenyl cation, propenyl neutral radical and propenyl anion) and cyclobutadiene system (square cyclobutadiene dication, square cyclobutadiene neutral molecule and square cyclobutadiene dianion), resultof diagonalization of the H matrices written for ethene system, propenyl system and cyclobutadiene system,molecular orbital energy level diagrams and expressions for energy and molecular wave functions for ethene system, propenyl system and cyclobutadiene system based on the result of diagonalization of the Hmatrices, and molecular orbital energy level diagrams for ethene system, propenyl system and cyclobutadiene system showing ground state and excited state electronic configurations.

Unit 4 Semiempirical Methods - Part 2

Application of SHM - nodal properties of molecular orbitals and Woodward-Hoffmann orbital symmetry rule, stability towards oxidation and reduction of various species in ethene system, propenyl system and cyclobutadiene system, geometry of cyclobutadiene molecule as predicted by SHM and its Jahn-Teller distortion, aromaticity and Huckel's $(4n + 2)$ π electron rule, and calculation of resonance (stabilizing) energy, bond order and atomic charges of various species in ethene system, propenyl system and cyclobutadiene system, strength of SHM, weakness of SHM (detailed explanation) - basis set is limited top orbitals (p_z orbitals), it treats only π electrons, and the overlap integrals, Fock matrix elements, electron spin and electron-electron repulsion are not calculated/accounted properly, extended Huckel Method (EHM) - minimal valence basis set, calculation of Fock matrix elements, and calculation of overlap integrals by Lowdin orthogonalization, EHM procedure, EHM calculation on protonated helium molecule, application of EHM - an overall idea, strength and weakness of EHM, SCF SE methods - Pariser-Parr- Pople (PPP) method and Complete Neglect of Differential Overlap (CNDO) method - basic principle (an exhaustive treatment is **not** expected).

Unit 5 Density Functional Theory and ab initio Method

(An exhaustive treatment is **not** expected)

Introduction to Density Functional theory and calculations, Kohn-Sham approach - the first and the secondHohenberg-Kohn theorems, introduction to ab initio method and calculation, basis sets for H, He and first,second and third row elements used in ab initio calculations - STO-3G, 3-21G, 3-21G**(*)** and 6-31G*****, these basis sets for a few molecular species (water, methane and carbene), basic principles of ab initio method (an idea only).

TEXT BOOK

1. *Computational Chemistry-Introduction to the Theory and Applications of Molecular and Quantum Mechanics - Errol Lewars*

25CHY643 Sustainable Chemical Science 3 0 0 3

Unit 1 Green Chemistry and Sustainability

History of green chemistry, chemical composition of the environment (air, water & soil - role of organic and inorganic molecules in pollution), the twelve principles of green chemistry (detailed description with examples), green chemistry as an expression of environmental ethics (Thrift Chemistry), the concept of sustainability, from green to sustainable chemistry, sustainable use of chemical feedstock, water and energy, quantifying greenness of a chemical reaction, green chemistry metrics - mass based, energy and environmental metrics, designing greener process, life cycle assessment (introduction and scope), green toxicology - the need, principles of toxicology, disposition of toxicants in organisms, non-organ system toxicity, mechanistic toxicology, quantitative structure–activity relationships, (environmental toxicology- persistence and bioaccumulation), non-cancer risk assessment, cancer risk assessment, stakeholders in sustainable policy implementation.

Unit 2 Chemistry in water

Definition and attributes of a green solvent, the principle and reasons for use of water in green chemistry- hydrophobicity - cyclodextrin chemistry, Lewis acids in aqueous media, Michael addition in water using triflates, green processes with base in water, green oxidations and reduction in water, on water conditions,use of water in microwave and ultrasonic technology.

Unit 3 Green solvents

Ionic liquids as green solvents - definition and notation - properties, synthesis and use in organic reactions,oxidation, oxidative carbonylation of aniline, Friedel–crafts reaction, Michael addition, Fischer Indole synthesis, benzoin condensation, dimethyl carbonates synthesis in ionic liquids. Super critical fluids- supercritical water and carbon dioxide - properties and organic transformations. (Diels Alder, Claisen rearrangement, Fisher Indole, Friedel–crafts reaction, oxidation and hydrogenation. Properties and application in organic transformation of green solvents like polyethylene glycol, glycerol, cyclopentyl methyl ether, 2-methyltetrahydro furan, perfluorinated (fluorous) Solvents - Fluorous Biphase Concept anddimethyl carbonate.

Unit 4 Green Chemistry and Catalysis

Importance of catalysis, turn over number and frequency, the basis of catalysis-kinetic phenomenon, basicsof homogeneous, heterogeneous and biocatalysis, Sabatier's principle, catalyst - deactivation, sintering, thermal degradation, inhibition and poisoning, catalyst promoters, modifiers, supported catalysts and reagents for green chemistry- heterogenized reactions for green chemistry, preparation of solid catalyst- slurry and co-precipitation, impregnation, hydrothermal synthesis- drying, calcination, activation and forming, selecting the right support, catalyst characterization- surface characterization methods, temperature programmed techniques, spectroscopy and microscopy. Common mechanism in enzyme catalysis immobilized enzymes, developing biocatalyst- rational design and directed evolution, non-enzymatic biocatalysts.

Unit 5 Green Chemistry Technologies and Alternate Energy Sources

Design for energy efficiency, photochemical reactions, advantages of and challenges faced by photochemical processes (examples). Microwaves as energy source in chemistry - properties of microwaves, microwave heating (effects), approaches to microwave-assisted organic chemistry-solvent free methods, MORE chemistry, continuous microwave reactor (CMR) - microwave batch reactor (MBR), examples of organic transformations. Sonochemistry and Green Chemistry - theoretical basis- cavitation inception, nucleation-bubble dynamics- examples of organic transformations, sono-chemical synthesis of nano-structured materials, electrochemical synthesis-materials manufactured using the process, organicelectrosynthesis- 3-bromothiophen from thiophene. Renewable sources of energy, solar energy, wind power, geothermal solution, hydropower (sources, merits and difficulties in widespread applications), Indian energy scenario-energy conservation act (2001)- features.

REFERENCES

1. *Green chemistry and engineering A Pathway to Sustainability, Anne E. Marteel-Parrish, Martin A.Abraham, American Institute of Chemical Engineers, Inc, John Wiley & Sons, Inc 2014.*
2. *Synthetic organic Sonochemistry, Jean-Louis luche, Springer Science Business Media New York, 1998*
3. *New Methodologies and Techniques for a Sustainable Organic Chemistry, Alessandro Mordini andFerencFaigl, Springer, 2008.*
4. *Green chemistry, Fundamentals and Applications, Suresh C. Ameta and Rakshit Ameta, CRC press,Taylor & Francis Group, 2013*
5. *Handbook of Green Chemistry, Vol5 Green Solvents- Reactions in Water, PualT Anastas, Chao Jun Li*
6. *Sonochemistry: theory, reactions, syntheses, and applications, Filip M. Nowak, Nova SciencePublishers, Inc, 2010.*
7. *Green Chemistry Metrics, A Guide to Determining and Evaluating506 Process Greenness, Dicks, Andrew,Hent, Andrei, Springer Briefs in Green Chemistry for Sustainability, 2015*
8. *Catalysis: concepts and applications, Gadi Rothenberg, Wiley-VCH Verlag& Co. KGaA, Weinheim,Germany, 2008*
9.

25CHY644 Sustainable Techniques in Chemical Sciences 3 0 0 3

Unit 1 From Industrial to Sustainable Chemistry

Industrial Sustainable Chemistry- Managing Intraorganizational Sustainability, Managing Horizontal Interorganizational Sustainability, Managing Vertical Interorganizational Sustainability. Integrated Pollution Prevention and Control- Best Available Techniques reference documents (BREFs), From Industrial Emissions Directive (IED) to Voluntary Systems, Policy Drivers for Sustainable Chemistry (Transition Concept), Development of a CSR Management System Framework. Sustainability AssessmentMethods and Tools- Sustainability Assessment Framework, Impact Indicators and AssessmentMethodologies, Environmental Impact Assessment, Economic Impact Assessment, Social Impact Indicators, Understanding Industrial Symbiosis-Cluster Management. Sustainability of Logistics in the Chemical Sector, Basic Principles of Chemical Leasing (ChL), Differences between Chemical Leasing andOther Alternative Business Models for Chemicals, Sustainable Chemical Warehousing- Risk Managementin the Chemical Warehouse, F^3-Factory concept, Indian energy security scenarios (IESS) 2047.

Unit 2 Process Intensification I

Opportunities and Perspectives for a Sustainable Process Design Definition and Concept, Reaction Engineering, Mixing Principles, Transport Processes, Enhanced Transport Processes, Integrating Process Steps. Moving from Batch to Continuous Processing, Spinning Disc Reactor (Design, Operating Features and Characteristics of SDRs- Green Synthesis of Nanoparticles using SDR), Micro Process Technology- Transport Intensification, Chemical Intensification, Process Design Intensification. Oscillatory Baffled Reactors- Design and operations. Monolith Reactors for Intensified Processing- Design, Hydrodynamics, Advantages and Applications- Cleaner Production of Fuels and Removal of Toxic Emissions. Cavitational Reactors, Mechanism, Reactor Configurations, Transesterification of Vegetable Oils Using Alcohol usingCavitation

Unit 2 Process Intensification II

Membrane Technology- Definitions, functions and operations, biocatalytic membrane reactors (Entrapment, Gelification and Chemical Attachment), biofuel production using enzymatic transesterification. Membrane technology in metal ion removal from waste water, membrane operations forthe production of optically pure enantiomers, integrated membrane processes for water desalination. reactive distillation technology and reactive extraction technology- principles, control design and applications. Reactive absorption technology in carbon dioxide capture, removal of nitrogen oxides, desulfurization, and in sulphuric and nitric acid production

Unit 4 Computer Applications in Catalytic Research

Computers as research tools in catalysis- a brief overview, a short over view of modelling methods, data- mining methods in catalysis (PCA, PLS and Artificial Neural networks)

Unit 5 Successful Example of Sustainable Industrial Chemistry

Detailed Process Chemistry of the current technologies and routes for the following chemicals in industry. Industrial Propene Oxide Production (CHPO (Chlorohydrin) Technology, PO/TBA Technology, PO/SM Technology, PO-only Routes). Synthesis of Adipic Acid (Current Technologies for AA Production- Two-Step Transformation of Cyclohexane, Alternatives for AA Production). Ecofining - New Process for GreenDiesel Production from Vegetable Oil. Direct

Oxidation of Benzene to Phenol, Friedel–Crafts Acylation of Aromatic Ethers Using Zeolites, Sustainable Chemistry in the Production of Nicotinates. Homogeneous catalysis: The Shell higher olefin process (SHOP) and Du Pont synthesis of Adiponitrile. Heterogeneous catalysis: The BP AVADA ethyl acetate process

REFERENCES

1. *Management Principles of Sustainable Industrial Chemistry, Genserik L.L. Reniers, Kenneth Sorensen,and Karl Vrancken (Eds), Wiley-VCH Verlag & Co. KGaA, Boschstr. 12, 69469 Weinheim, Germany,2013*
2. *Sustainable Development in Practice, Azapagic, A., Perdan, S. (eds.), Wiley-VCH Verlag& Co. KGaA,Boschstr. 12, 69469 Weinheim, Germany, 2011*
3. *The Art of Process Chemistry, Yasuda, N. (ed.), Wiley-VCH Verlag& Co. KGaA, Boschstr. 12, 69469Weinheim, Germany, 2011*
4. *Sustainable Industrial Chemistry, Centi, G., Trifiro, F., Perathoner, S., Cavani, F. (eds.), Wiley-VCHVerlag& Co. K GaA, Boschstr. 12, 69469 Weinheim, Germany, 2009*
5. *Green chemistry, Fundamentals and Applications, Suresh C. Ameta and RakshitAmeta, CRC Press, Apple Academic Press, Inc, Taylor & Francis Group, 2013*
6. *Catalysis: concepts and applications, Gadi Rothenberg, Wiley-VCH Verlag& Co. KGaA, Weinheim, Germany, 2008*

25CHY645 Introduction to Nanocomposites 3 1 0 4

Introduction to Nanomaterials Introduction to nanomaterial science, Interdisciplinary nature, Structure of nanomaterials, Length scales, de-Broglie wavelength &exciton Bohr radius, Fundamentals of Quantum Mechanics: wave function, Schrödinger equation, uncertainty principle, quantum wells, quantum dots, quantum wires.

Characterization techniques Introduction to materials and characterization techniques; Spectroscopic methods-UV-Visible and vibrational spectroscopy- Infrared and Raman, Electron spectroscopies- X-ray photoelectron spectroscopy, Ultra-violet photoelectron spectroscopy, Auger electron spectroscopy; X-ray techniques- X-ray diffraction, X-ray fluorescence spectrometry; Optical microscopy, Electron microscopy- SEM, TEM; Scanning Probe microscopies- STM and AFM.Nanocomposites

Introduction to Nanocomposites, Composite material, Mechanical properties of Nano composite material: stress - strain relationship, toughness, strength, plasticity. Introduction to Nanocomposites, Structure and Properties - Dispersion, Matrix Bonding, and Functionalization, matrix-nanomaterial interactions. Thin film nanocomposites; Modeling of nanocomposites.

Ceramic Matrix Nanocomposites (CMNC) Mechanical alloying, thermal spray powder method; Polymer precursor route; Spray pyrolysis; Vapour techniques (CVD and PVD) and Chemical methods, which include the sol-gel process, colloidal and precipitation approaches and the template synthesis synthesis

Metal Matrix Nanocomposites (MMNC) Spray pyrolysis; Liquid metal infiltration; Rapid solidification; Vapour techniques (PVD, CVD); Electrodeposition and Chemical methods, which include colloidal and sol-gel processes.

Polymer Matrix Nanocomposites (PMNC) Nano coatings, Nano particle dispersion in polymer matrix-processing of polymer nano composites, processing of organic-inorganic hybrid

materials. Intercalation of the polymer or pre-polymer from solution; In-situ intercalative polymerization; Melt intercalation; Direct mixture of polymer and particulates; Template synthesis; In-situ polymerization; Sol-gel process. Chemical and electrochemical methods.

TEXTBOOKS/ REFERENCES:

1. T. Pradeep, nano the essentials: UnderstandingNanoscience and Technolgy, McGrawHill professional publishing, 2008.
2. Charles P.Poole.Jr.& Frank J.ownes, Introduction to Nano technology – John wielly&sonsInc.Publishers -2006
3. Guozhong Cao, Nano structures and Nano materials: Synthesis, properties and applications, Imperial College press.
4. P.M. Ajayan, L.S. Schadler and P.V. Braun, Nanocomposite Science &Technology, Wiley-VCH GmbH Co.
5. Z.L. Wang, Characterization of nanostructured materials
6. B. Roszek , The Handbook of Nanotechnology –Wiley, 2005
7. Nanomaterials, Nanotechnologies and Design: An Introduction for Engineers and Architects- Daniel L. Schodek, Paulo Ferreira, Michael F. Ashby (Butterworth -Heinemann
8. Nanostructures and Nanomaterials: Synthesis, Properties, and Applications" (2 nd Edition) (World Scientific Series in Nanoscience and anotechnology) -Guozhong Cao and Ying Wang (Imperial College Press)

25CHY646 Electro and photocatalytic material 3 1 0 4

Unit 1: Basics of Electrochemistry
Electrochemical cells: Galvanic cell. Half reactions and reversible electrodes: metalmetal ion electrodes, Gas electrodes – hydrogen electrode, oxygen electrode, oxygen electrode, Metal – insoluble metal salt electrodes – calomel electrode, oxidation – reduction electrode. Over potential. Butler – Volmer equation. The Nernst equation. Concentration cells: Electrode concentration cells, Electrolyte concentration cells. Ion –solventinteraction. Ion transport. Debye – Huckel treatment. Onsagar equation.
Unit 2: Catalysis
Theories of catalysis: Intermediate compound formation theory of catalysis, Adsorption theory of catalysis. Heterogeneous catalysis: classic gas/solid system, the concept of the active site, promoters, modifiers and poisons. Homogeneous catalysis: elementary steps in homogeneous catalysis, ligand exchange, oxidative addition, reductive elimination, insertion and migration, deinsertion and beta –elimination, nucleophilic attack on a coordination site, industrial examples: Wacker oxidation process.
Unit 3: Hydrogen evolution
Sustainable energy source; renewable energy, hydrogen energy economy, hydrogen production, methods of hydrogen storage, hydrogen as an engine fuel. Hydrogen evolution:,Electrocatalytic and photocatalytic water splitting. Properties of electro/photocatalytic materials. Role of

cocatalyst in hydrogen evolving reaction.Advantages of electro/photo catalyst in hydrogen evolution. Difficulties in the development of electro and photocatalyst.

Unit: 4: Materials and its characterization

Doping with metals- nonmetals as modifiers. Dye sensitized Titania, Coupled semiconductors, conducting polymers as dopant, Supported Titania catalysts. Advanced techniques used in electrocatalysis: Electrochemical impedance analyzer-principle, OCP measurement, UV Visible spectro photometer, Photo simulator. GC analysis for hydrogen evolution rate.

Unit5: Advanced electrochemical methods

Principle and applications of potentio dynamic polarization. Electrochemical impedance analysis : principle, applications, Nyquist and Bode plots, Different circuit used in impedance analysis. Principle of cyclic voltametry. Linear sweep voltametry – linear potential wave form

TEXT BOOKS/ REFERENCES:

1. J.O.M. Bokris and A.K.N. Reddy "Modern Electrochemistry", Plenum.
2. D.R.Crow "Principles and Applications of Electrochemistry" S. Thomes.
3. Hans-Jurgen Butt, Karlheinz Graf, Michael Kappl ;Physics and Chemistry of interfaces,Wiley-VCH VerlagGmbh& Co.
4. Leite, Edson Roberto; Nano Structured Materials for Electrochemical Energy
5. R.de Levie, P.Delahay, Adv.Electrochem.Eng, Vol-6, Inter science, 1967. Production and Storage-2009
6. Antoni Llobet, "Molecular water oxidation catalysis", Wiley

25CHY647 Silicon Chemistry and Drug Design 4 0 0 4

Unit 1 Physicochemical properties of drugs in relation to biological action

Acid-Base Properties, Water solubility, Partition coefficient, drug administration, drug distribution, metabolism (Phase I and Phase II) and toxicity of drug receptor interaction, conformational flexibility and multiple mode of action, optical isomerism and biological activity, selected physico-chemical properties (Ionization, hydrogen bonding and biological action, chelation and biological action, oxidation - reduction potential and biological action, absorption and orientation at surfaces) Enzymes, hormones and Vitamins - representative cases, nomenclature, classification and characteristics of enzymes, mechanism of enzyme action, factors affecting enzyme action, cofactors and co-enzymes, enzymes in organic synthesis, mechanism of enzyme catalysis, enzyme inhibition.

Unit 2 Essentials of drug design

Molecular mimetics, drug-lead modification, drug design using QSAR and computer assisted design, assessment of drug activity, receptors and drug action, mechanism of drug action, drug metabolism pathways, Drug potentiation, drug antagonism and drug resistance

Unit 3 Silicon in medicinal chemistry

Organosilicon molecules with medicinal applications, chemical properties of organic silicon relevant for medicinal chemistry, silicon containing amino acids and analogues, Organosilicon based fluoride acceptors for imaging, Trialkyl silyl derivatives of drugs and biologically active molecules, Hydrophobic quaternary silanes, Increased hydrophobicity of silyl groups & effect

on biological activity,
Unit 4 Silicon derivatives
Disilyl&disilacyclic compounds & related derivatives, spirosilanes& other silacyclic derivatives, Diphenyl silane derivatives, Silyl groups as isosteres of quaternary ammonium groups, Silyl ethers as hydrophobic substituents, silicates, silanols, silanediols&silanetriols, Hypervalent silicon compounds, stability of organo silicon compounds, silyl ethers and drug delivery strategies related to silicon, metabolism of organosilicon molecules.
Unit 5 Medicinal agents
Medicinal agents belonging to alkaloids, steroids, polypeptides, modified nucleic acid bases, sulphonamide and sulpha drugs, antibacterials - sulpha drugs, substituted sulphonamides, anticonvulsants, anticoagulants, antiamoebic agents, antihelmintic agents, anti-malarial agents, diuretics and cardio vascular agents, drugs for AIDS, medicinal agents affecting CNS, analgesics, antipyretics, antiseptics and disinfectants.

TEXTBOOKS/ REFERENCES:

1. John M beak and John H Block, 'T Wilson, O. Gisvold and R. F. Deorge - Text book of Organic, Medicinal and Pharmaceutical Chemistry', 7th edition, J.B. Lippincott Williams and Wilkons Company, 1977.
2. A.Burger, 'Medicinal Chemistry', 3rd edition, Wiley Interscience, 1970.
3. V.K.Ahluwalia and Madhu Chopra, 'Medicinal Chemistry', Ane Books pvt Ltd, 2008.
4. V.Kothekar, 'Essentials of Drug Designing', 14th edition, Dhruv publications, 2005.
5. V.K.Ahluwalia, LalitaS.Kumar and Sanjiv Kumar, 'Chemistry of Natural Products', Ane Books India.
6. L.P.Graham 'An introduction to Medicinal Chemistry', 3rd edition, Oxford University Press, 2005.
7. Fujii S and Hashimoto Y; Progress in the medicinal chemistry of silicon: C/Si exchange and beyond;. Future Med Chem. 2017 Apr; 9(5):485-505.
8. Franz AK1, Wilson SO; Organosilicon molecules with medicinal applications; J Med Chem. 2013 Jan 24;56(2):388-405

25CHY648 Polymer Science 3 1 0 4

Polymerisation mechanisms
Chemistry of condensation polymerisation, types of condensation polymers. Types of stepwise reactions. Interfacial condensation, Ring opening polymerisation reactivity and molecular size. Poly functional condensation polymerisation gelation, gel point experimental observation, Molecular weight distribution, ring scission polymerisation, Metathesis polymerisation, group transfer polymerisation
Heat and free energy of polymerisation, Cationic polymerisation – mechanisms and kinetics of anionic polymerisation, examples, kinetics and mechanism, co -ordination polymerisation, polymerisation with supported metal oxides. Different types of catalysts, kinetics of step polymerisation, copolymerisation, and reactivity ratios.
Methods of polymerisation
Copolymerization: types of copolymers, the copolymer composition

equation,monomerreactivity ratio and copolymer structure, influence of structural effectsof monomers on monomer reactivity ratios, the Q-e scheme, synthesis ofalternating, block and graft copolymers.Step
reaction(condensation) polymerization-kinetics and mechanism of stepreaction polymerization, Carothers equation, number distribution and weightdistribution functions, polyfunctional step reaction polymerization, prediction of gel point. Controlled polymerization methods-nitroxide mediated polymerization, AtomTransfer Radical Polymerization(ATRP), Reversible Addition Fragmentation Termination(RAFT), electrochemical polymerization, metathetical polymerization, group transfer polymerization.
Polymer reactions
Hydrolysis, acidolysis, aminolysis, hydrogenation, addition and substitution reactions, Reaction of various specific groups, cyclisation reaction, cross linking reactions, reactions leading to graft and block copolymer.
Polymer viscoelasticity, introduction to the viscoelastic properties of polymers,some simple linear viscoelastic models-Maxwell model, Voigt model, seriescombination of Maxwell and Voigt model, generalized linear viscoelasticity, the Boltzman principle, the linear viscoelastic behavior of polymer solids, creepexperiments, stress relaxation experiments, stressstrain experiments, oscillatoryexperiments, the elastic modulus, time temperature equivalence, time-temperaturesuperposition principle.
Rheological properties of polymers -introduction to polymer melt rheology,Newtonian
fluids,non-Newtonian fluids, pseudoplastic, thixotropy, St. Venantbody, dilatant, complex rheological fluids, rheopectic fluids, time dependentfluids, time independent fluids, power law, Weissenberg effect, laminar flow,turbulent flow, die swell, shark skin, viscous flow, melt flow index.Transport in polymers-diffusion, liquid and gas transport, Fick's law, theories ofdiffusion.

TEXTBOOKS/ REFERENCES:

1. F.W. Bilmeyer, Textbook of polymer science, Wiley Interscience,1971
2. H. R. Allock and F.W. Lampe, contemporary polymer chemistry, Prentice hall,1981
3. G. Odian, Principles of Polymerisation, McGraw Hill,1970
4. Polymer science and technology, Fried
5. Physical Chemistry of Macromolecules, Tanford, C. John Wiley,1961
6. P.J.flory, Principles of Polymer Chemistry, University Press, London, 1953

25CHY649 Polymer Technology 3 1 0 4

Polymer processing
Processing methods for the manufacture of products with dry rubber, blending and mastication,master batching of of polymers, mixing and compounding in mills and internal mixers,calendaring, sheeting, fabric coating, extension, moulding. Batch curing methods: autoclavecuring, gas curing, over curing, water curing, lead curing, cold curing. Processing methods forplastic products manufacture: methods of mixing, injection, compression and transfer moulding, extrusion, calendaring, thermoforming, blow moulding, rotational moulding and slush moulding.

Polymerization techniques
Bulk polymerization, solution polymerization, emulsion polymerization, suspension polymerization, interfacial polymerization, melt polycondensation, solution polycondensation, solid and gas phasepolymerization.
Polymer testing
Importance of standards and standard organisations. Processability and performance, testing of plastics and rubbers, material characterisation tests such as melt flow index, capillary rheometer test, viscosity test, gel permeation, chromatography, and thermal analysis.
Material characterisation tests for thermosets. Apparent bulk density, bulk factor and pourability of plastics materials. Flow tests such as spiral blow, cup flow, viscosity tests for thermoset resins bubble viscometer, Brookefield viscometer, gel time and peak exothermic temperature ofthermosetting resins.
Polymer properties
Mechanical properties: Tensile strength, flexural and compression properties, creep properties, stress relaxation, impact properties, shear strength, abrasion, fatigue and hardness etc. Thermal properties: heat deflection temperature, vicat softening temperature, torsion pendulum test, thermal conductivity, thermal expansion, brittleness temperature.
Electrical properties; dielectric strength, dielectric constant, dissipation factor, electrical resistance, arc resistance etc. Weathering properties: UV, IR, X-ray, microorganisms, humidity, ozone oxygen, water, thermal energy, chemical factors.
Optical properties: Refractive indices, luminous transmittance and haze, colour, gloss.
Polymer characterisation
Functional group analysis, use of chemical reactions and degradation for structural analysis, various microscopic techniques such as light microscopy, electron microscopy etc. and spectroscopic techniques such as IR, FTIR, NMR,EPR,UV-Visible, Raman, fluorescence etc.

TEXTBOOKS/ REFERENCES:

1. J.A. Brydson, Plastics Materialsa,Butterworths,1989
2. F.W. Bilmer, Textbook of polymer science, Wiley interscience,1971
3. W.A. Holmes Walker, Polymer Conversion, Applied Sciences 1975
4. Maurice Morton, Rubber technology
5. M. Blow, Rubber Technology and Manufacture, Newness, Butterworths,1977
6. R.T Fenner, Principles of polymer processing, Macmillan,1979

25CHY650 Introduction to Photochemistry 4 0 0 4

Unit-1 Light induced processes in everyday life
The Nature of Light, Photosynthesis, Vision, Photoresponse Mechanisms in Plants and Animals, Photomedicine, Photochemical effects of Visible and UV light, Bioluminescence, Photodegradation, Imaging processes
Unit 2 - Photochemistry - Principles and Reactions
Rates of absorption,-EinsteinBeerLaw, FluorescenceLambert'slifetimes, quantumLaw, Star yield; Fluorescence, Phosphorescence, Jablonski diagram, cis-trans isomerisation, Paterno-Buchi reaction, Norrish Type I and II reactions, photo reduction of ketones, di-pimethane

rearrangement, photochemistry of arenes, Hoffmann-Loffler-Freytag reaction, Barton reaction, Photochemistry of cyclohexadienones.

Unit 3- Excited state processes

Adiabatic and Non-adiabatic processes, Monophotonic and multiohotonicproceses, Primary and secondary photochemical processes,kinetics of photochemical reactions, photo-ionization , light induced electron capture and electron transfer reactions, Intramolecular and intermolecular electron transfer, Marcus-Hush Model of Electron transfer, Electronically excited moleculesExcimers and Exciplexes, Charge transfer in excited states, twisted intramolecular charge transfer state, quenching of excited states, Stern Volmer equation, electron transfer, energy transfer,paramagnetic quenching, concentration quenching, static and dynamic quenching

Unit 4-Mechanisms of Photochemical reactions

Organic Photochemistry -Quenching, Sensitization, Unimolecular and bimolecular reactions, Photoelectrochemistry-reactions at electronically excited semiconductor electrodes, Inorganic photochemistry, photochemistry and photophysics of metal complexes, Photochemistry in solids and organized assemblies, Photochemical reactions in glasses, excitons in polymers and crystals, photochemistry in micelles, photochemical reactions of free radicals

Unit 5- Light in Industry

Photographic processes-Spectral sensitization, Colour photography, Instant photography,Electrophotography, Photopolymerisation and photochemical degradation of polymers, Phototchemistry in synthesis –photochlorination of polymers, Synthesis of caprolactam, Vitamin D, Photochemistry of Dyes and Pigments, Phtochromism, Energy conversion and storage –photoelectrochemicalcells,Ozone layer-its photochemical formation and degradation.

TEXT BOOKS / REFERENCES:

1. Modern molecular photochemistry- N. J. Turro (University Sci. 1991)

2. Chemistry and Light- P. Suppan (RSC 1999)

3. Organic and Inorganic Photochemistry; Volume 2 of Molecular and supramolecular photochemistry - V. Ramamurthy, Kirk S. Schanze (M.Dekker, 1998)

4. Organic Photochemistry- James MorrissCoxon, Brian Halton, (CambridgeUniversity Press, 1987)

5. Principles of Organic Synthesis- R.O.C. Norman &Coxon (CRC Press; 1993)

6. Fundamentals of Photoinduced Electron Transfer- G. J. Kavarnos (Wiley-VCH, 1993)

7. Essentials of Molecular Photochemistry - A Gilbert and J Baggott(Blackwell,1991)

8. Principles and applications of photochemistry- R. P. Wayne (OUP 1988)

9. Photochemistry - C. E. Wayne and R. P. Wayne (OUP Primer)

25CHY651 FRONTIERS OF PHOTOCHEMISTRY 4-0-0-4

Unit 1 Spectrophotometry, Measurements in Solution

The Absorption Spectrum,The General Absorption Characteristics of Molecules ,Qualitative Analysis, Quantitative Treatment of the Absorption Intensity ,Quantitative Analysis ,The Method of the Standard Additions, Analysis of Mixtures of Absorbing Species,Spectrophotometric Titrations ,Instrumentation,The Light Source,The Monochromator ,The Sample Holder ,The Detector ,The Spectrophotometers ,The Sample Measurement. ,The Instrumental Precision ,Experimental Examples

Unit 2 Photochemical Techniques

Photochemical Apparatus, Light Sources , Selection of the Exciting Radiation , Reaction Cells,Optical Material , Control of Temperature and Stirring, Photoreaction Quantum Yield,Chemical Actinometers, Potassium Ferrioxalate ,Potassium Reineckate, Azobenzene , Aberchrome 540 ,A Photochromic Diarylethene Compound ,Irradiation Experiments.

Unit 3 Spectrofluorimetry, Spectroelectrochemistry & CD spectroscopy

Spectrofluorimetry ,Reference Standards for the Determination of Fluorescence Quantum Yields ,Reference Standards for the Determination of Phosphorescence Quantum Yields, Luminescence Measurements on Solid Samples , Sample Inhomogeneity ,Concentration Effects , SpectroelectrochemistryAbsorption and Emission Spectroscopy with Polarized Light , Linear and Circular Dichroism Spectroscopy , Polarized Light, Birefringence and Circular Dichroism, Linear Dichroism, Observables in Circular Dichroism Spectroscopy

Unit 4 Transient Absorption Spectroscopy

Transient Absorption with Nanosecond Resolution, Measure of Absorbance Change,The Sample Compartment , The Optical System ,The Electronic Detection System, Transient Absorption Spectroscopy in Supramolecular Systems ,Fullerene Derivatives ,Ligand–Protein Complexes , Sub-Nanosecond Transient Absorption ,Shortening the Laser Pulse, Ti: Sapphire Laser ,Chirped Pulse Amplification , Regenerative Amplification, Ultrafast Transient Absorption Spectroscopy, Femtochemistry ,Pump and Probe Experiments ,Photoinduced Electron Transfer in a Multichromophoric System, Femtosecond Systems, Experimental Suggestions

Unit 5- Supramolecular Photochemistry

Definition of a Supramolecular System , Photoinduced Energy and Electron Transfer in Supramolecular Systems , Excimers and Exciplexes ,Electron Transfer Processes,MarcusTheory, Quantum Mechanical Theory ,Optical Electron Transfer , Energy Transfer Processes,Coulombic Mechanism, Exchange Mechanism,The Role of the Bridge in Supramolecular Systems

TEXT BOOKS/ REFERENCES:

1. The Exploration of Supramolecular Systems and Nanostructures by Photochemical Techniques -Paola Ceroni Springer, 2012.

2. Electrochemistry of Functional Supramolecular Systems (The Wiley Series on Electrocatalysis and Electrochemistry) -Paola Ceroni, Alberto Credi, Margherita Venturi Wiley-Interscience, 2010.

3. Supramolecular Photochemistry- Vincenzo Balzani, Springer, 1987.

4. Designing Dendrimers - Sebastiano Campagna, Paola Ceroni, Fausto Puntoriero,Wiley, 2011.
5. Electron Transfer in Chemistry: Molecules-level electronics, imaging and information, energy
and the environment; Volume 5 of Electron Transfer in Chemistry- Vincenzo Balzani, WileyVCH, 2001

25CHY652 Colour Chemistry 4 -0-0 4

Module 1 : Colour Chemistry
Colour, colour wheel, complementary colour, Theories of colour and chemical Constitution: Witt's chromophore – auxochrome theory, Resonance theory, Modern theories of colour: Valence bond theory, Molecular Orbital theory.
Module 2: Chemistry of Dyes
Requirement of dyes, Chemical nature, Classification: Natural and synthetic, Based on structure: (a) Triphenyl methane, (b) Azo dyes (c) Anthraquinone dyes (d) Indigoid dyes (e) Xanthene dyes (f) Cyanine dyes (g) Squaraine dyes (h) Croconine dyes, Classification based on application. Quantitative Evaluation of Dyes: Pariser-Parr-Pople molecular orbital method (PPP MO), Huckel molecular orbital (HMO).
Module 3. Nomenculture and synthesis of representative dyes
Based on Colour Index alphabets : B, C, G, 2G, 3G, H, HE, L, ME, R. General methods of Synthesis of dyes: (a) Cyanines, (b) Hemicyanines, (c) Squaraines (d) Azo dyes, (e) croconaines. Synthesis of individual dyes such as Aminosquaraines, Alizarin, Mercurochrome-Red, Congo-Red, Amido Black 10B, Procion Red, Fuchsine.Module 4 : Applications of Dyes
Appication in PDT, Sensing, Bioimaging, Photovotaic devices, paint industry, Non –linear optical applications of Dyes, Applications of encapsulated Squaraine dyes, Bioconjugated Squaraine dyes, Aggregation properties and applications of cyanine dyes, Solar cell applications, Miscellaneous applications.
Module 5 : Chemistry of Pigments
The flower pigments: Anthocyanins, Flavones, structure of Delphinidin Chloride, Pelargonidine Chloride, Quercitin. Phthalocyanine : Copper Phthalocyanine, applications. Carotenoids: structure of β- carotene, lycopene, application in food industry. Fluorescent brightening agents: synthesis and applications of Blankophor – R, Blankophor –WT. Inorganic Pigments.

Text books /References

[1] Dyes and Pigments: New Research: Arnold R. Lang, Nova Science Publishers, Inc.2008.
[2] Modern Organic Chemistry, Jain, M.K. & Sharma, S.C. Vishal Publishing Co. 2010.
[3] Handbook of natural dyes and pigments: Har Bhajan Singh, Kumar, Avinash Bharati, Woodhead Publishing India Pvt Ltd, 2014.
[4] Handbook of Fluorescent Dyes and Probes: R. W. Sabnis, Wiley, 2015

25CHY653 Chemistry of Natural products 4-0-0 4

Unit 1

Sources of natural products: Primary and Secondary Metabolites, Traditional Sources of Natural Products, Sources of Microbes, Venoms and Toxins, A brief account of major classes of secondary metabolites with special reference to plant families such as Zingiberacea, vitaceae, asteraceae, celastraceae, sapindaceae, moraceae, musaceae, fabaceae,etc : Alkaloids triterpenoids, flavanoids, phenolics and phenolic acids, Steroids, Coumarines, Quinines, Cyanogenic glycosides, Amines and non protein aminoacids, Nutraceuticals and Pharmaceuticals

Unit 2

Extraction of Natural Products: Water-Steam Distillation, Supercritical Fluid Extraction, Solvent Partitioning , Refined Isolation Techniques and Chromatography, Separations of Nonpolar and polar Compounds, Charcoal, Reverse Phase Resins, High-Performance

Unit 3

Separation, Purification and characterisation techniques- TLC, HPLC, HPTLC Liquid Chromatography, Capillary Electrophoresis, Polyamide Gel Chromatography, Size-Exclusion Chromatography and GC. Characterization techniques- LC-MS, ID and 2D NMR experiments, Cell culture techniques,NMR, UV-IR, XRay Crystallography,Circular dichroism ,Mass spectrometry

Unit 4

Anti-Infectives from Nature-Antimicrobial β-Lactams, Structure Elucidation of Penicillin, Isolation of Penicillin, Cephalosporin, Isolation of Cephalosporin C, Isolation of Thienamycin, Antibiotic Macrolides: Erythromycin, Antiparasitic Drugs: Avermectins, Tetracyclines, Terpenes in Human Health.

Unit 5

Natural Products in Food, Spices, and Toxins Sweeteners, Xylitol,Aspartame, Sucralose, Stevia, Licorice, Agave ,Spices, Examples of Toxins from Plants,Toxic Mushroom: Amanita sp, Marine Toxins from Algae, Marine Toxins: Fish, Spider Venom,Conus Snail Toxins, Poisonous Frogs

Text Books

1. Natural Products Chemistry- Sources, Separations, and Structures- Raymond Cooper, George Nicola © 2015 by Taylor & Francis Group, LLC, CRC Press

2. Plant-derived Natural Products- Synthesis, Function, and Application- Anne E. Osbourn • Virginia Lanzotti, Springer

3.Bioactive natural products: detection, isolation ansd structural determination Ed By Sm Colegate & RJ Molyneux, CRC Press, (2007)

REFERENCES

1.Natural products: Essential resources for human survival, Y. Z. Zhu et al, World Scientific Publishingn Co. Pte Ltd, London(2007)

2.Medicinal natural Products: A biosynthetic approach, Paul M. Dewick, John Wiley &Sons(2001)

3.Bioactive natural products: detection, isolation ansd structural determination Ed By Sm

Colegate & RJ Molyneux, CRC Press, (2007)
4. Natural Products Isolation, S D Sarker et al, Humana Press, (2005)
5.Bioactive Compounds from Natural Sources, Second Edition, Corrado Tringali, CRC Press,2011
6. Chemistry for Pharmacy Students, General, Organic and Natural Product Chemistry,Satyajit D. Sarker University of Ulster, Coleraine, Northern Ireland, UK Lutfun Nahar,University of Ulster, Coleraine, orthern Ireland, UK, John Wiley and Sons,LTD., 2006
7.Chemistry of Natural Products, Sujata V. Bhat, Bhimsen A. Nagasampagi, MeenakshiSivakumar,First Edition , Springer, Berlin , 2005
8-Trease, G.E.and Evans, W.C.; "Pharmacognosy", W.B. Saunders Publishers, Ltd, 15th ed., 2002.

25CHY654 Introduction To Nanotechnology/Nano Chemistry 4-0-0-4

Unit 1 Introduction to Nano
Historical introduction, Bulk vs. nano size, The concept of nano and it evolution. Size-dependence of properties. Electronic structure theory of metals and semiconductors. Quantum size effects. Metal nanoparticles, semiconductor quantum dots, Nano porous materials – mesoporous and micro porous materials, carbon nanostructures: fullerenes, carbon nanotubes, micelles, bilayers, biological nanostructures.
Unit II Nanomaterials and Properties
Semiconductor nanoparticles optical and electronic properties, Nano porous materials – meso porosity and micro porosity, Magic numbers, Surface Plasmon resonance, Mesoporous materials: SiO2 and TiO2 and their applications. Self-assembled nanostructures.
Unit III basics and scale of nanotechnology
(9 hours) Introduction – Scientific revolutions –Time and length scale in structures – Definition of a nano system –Dimensionality and size dependent phenomena – Surface to volume ratio - Fraction of surface atoms – Surface energy and surface stress- surface defects-Properties at nanoscale (optical, mechanical, electronic and magnetic).
Unit IV Nanomaterials Synthesis and Applications
General: Top down and bottom up approach, Chemistry of nanostructures and chemical synthesis -Wet chemical routes, solution phase and vapor phase synthesis, sol-gel synthesis. Synthetic methods for metal and semiconductor nanoparticles, Template-based synthesis of mesoporous metal oxides. Synthesis of carbon nanostructures and fullerenes, Special applications of semiconducting nanomaterials- Photo catalysis, super hydrophilicity, Self-cleaning applications, Dye sensitized solar cells and electrochromic device applications.
Unit V Surface chemistry and Catalysis of nanomaterials
Adsorption by solids, Factors influencing adsorption. Adsorption isotherms - Freundlich and Langmuir adsorption isotherms, BET theory of multilayer adsorption (no derivation). Application of adsorption. General principles of catalysis - Typical mechanism, Catalysis and reaction energetic, Catalytic materials. Types of catalysis – Homogeneous catalysis, Heterogeneous catalysis-adsorption and catalysis, Uni-molecular surface reaction- bimolecular surface reactions-Langmuir-Hinshelwood mechanism. Significance of catalysis. Catalytic Inhibitors, Poisons and Promoters.

TEXT BOOKS/ REFERENCES:

1. C. P. Poole Jr. & F. J. Ownes. Introduction to Nanotechnology. Wiley India (2007), New Delhi.
2. T. Pradeep. Nano: The Essentials. Tata McGra Hill (2007), New Delhi.
3. K. J. Klabunde (Ed.) Nanoscale Materials in Chemistry, John Wiley & Sons (2001).
4. Hari Singh Nalwa (Ed.), Nanostructured materials and nanotechnology, Academic Press, New York (2002).
5. D. Vollath. Nanomaterials, Wiley-VCH (2008).
6. K.K. Cathopadhyay & A.N. Banerjee, Introduction to Nanoscience and Technology, PHl Learning Pvt. Ltd. (2009).
7. G. A. Ozin, A. C. Arsenault, L. Cademartiri, Nanochemistry: A Chemical Approach to Nanomaterials, Royal Society of Chemistry (2009) London.
8. P. Atkins & J. De Paula, Atkins's Physical Chemistry, 8th Edition, W.H. Freeman & Co., 2006.
9. G. K. Velupillai, Physical Chemistry, Printice Hall of India.
10. K. J. Laidler, J. H. Meiser and B. C. Sanctuary, Physical Chemistry, Houghton Mifflin Company, New York, 2003.
11. Richard I. Masel, Chemical Kinetics and Catalysis , Wiley Inter science, 2001.
12. Skoog and West, Principles of Instrumental Analysis

25CHY655 Retrosynthetic Analysis 4 0 0 4

Unit I Introduction
The disconnection approach, designing a synthesis, FGI, synthons, order of events, choosing a disconnection, synthesis of aromatic compounds, Chemoselectivity in synthesis – One group CX disconnections – alcohols, ethers, sulphides, alkyl halides, Two group C-X disconnections – 1,1-, 1,2- and 1,3-difunctionalozed compounds. protection and deprotection of functional group including C-C multiple bondsUnit II C-C bond formations and disconnections Reversal of polarity, protecting groups in synthesis, cyclisation and radical reactions, amine synthesis, 1,1 and 1,2 C-C disconnections, synthesis of alcohols, carbonyl compounds and carboxylic acids, synthesis of other compounds from alcohols, carbonyl compounds by one group C-C disconnections, enolate chemistry.
Unit III Two group disconnections
Diels-Alder reactions, 1,3-difunctionalized and α, β-unsaturated carbonyl compounds, base catalysed reactions, 1,5-difunctionalized compounds, Michael addition and Robinson annulations, 1,2-difunctionalized compounds, methods using acyl anion equivalents, 1,4- and 1,5-difunctionalized reactions, reconnections,.
Unit IV Ring synthesis
Three, four and five membered ring synthesis and retrosynthesis, pericyclic reactions for ring synthesis, radical and photochemical reactions, six membered rings, aromatic heterocycles, aromatic heterocycles with two heteroatoms, rearrangements in synthesis, electrophilic substitution reactions, named reactions in heterocyclic synthesis.
Unit V Retrosynthesis in action

Advanced strategies, retrosynthesis in industry, stereoselectivity and regioselectivity in synthesis, using alkenes, alkynes and nitro compounds in synthesis, retrosynthetic analysis and synthesis – practice problems. Seminar

Text Books:

1. Organic Synthesis – The disconnection approach by Stuart Warren, John Wiley and Sons, 2004.
2. Organic Chemistry by Clayden, Greeves, Warren and Wothers, Oxford University press, 2001.
References:
1. R. O. C. Norman, Principles of Organic Synthesis, Chapman and Hall 2nd Edition, 1995.
2. Jerry March, Advanced Organic Chemistry, Wiley Interscience, 2001.

❖ Syllabus of Open Elective Papers:

SEMESTER I

25CHY271 **Chemistry in Daily Life** **3 0 0 3**

Course Outcomes:

CO1: Students will be able to identify and explain the chemical principles underlying commondaily processes.
CO2: Students will evaluate the environmental impact of chemicals used in everyday life, including industrial products.
CO3: Students will understand the chemistry of food and nutrition, including the role of macronutrients, micronutrients, food additives, and food preservation techniques.
CO4: Students will be able to evaluate the role of biomolecules in health and well being and recognize the therapeutic uses of common drugs.
CO5: Students will be able to measure and interpret key water quality parameters and evaluatethe presence of contaminants in water samples.

UNIT-I Acids, Bases and Non-aqueous solvents
Concepts of acids and bases – hard and soft acids and bases - Pearson's concept, HSAB principle and its application - basis for hard - hard and soft - soft interactions - non-aqueous solvents - general characteristics of non-aqueous solvent - melting point, boiling point, latent heat of fusion and vaporization, and dielectric constant - reactions such as complex formation, redox, precipitation and acid base type in non-aqueous solvents like liquid ammonia, liquid SO_2 and liquid HF.

Unit 2 Water Technology
Soft and hard water – Hardness – units of hardness – alkalinity - dissolved oxygen – water for various types of industries – treatment of water by ion exchange process - boiler feed water – boiler compounds – internal and external conditioning - water for drinking - municipal water treatment – desalination by RO and electro dialysis.

UNIT-III Biomolecules and Drugs
Carbohydrates: Structure, function and Chemistry of some important monoand disaccharides, Vitamins: Classification and Nomenclature. Sources, deficiency diseases and structures ofVitamin A1, Vitamin B1, Vitamin C, Vitamin D, Vitamin E & Vitamin K1. Drugs: Classification and nomenclature. Structure and function of: Analgesics – aspirin, paracetamol. Anthelmentic drug: mebendazole. Antiallergic drug: Chloropheneramine maleate. Antibiotics: Pencillin V, Chloromycetin, Streptomycin. Anti-infalmmatory agent: Oxypheno-butazone. Antimalarials: Primazuine phosphate & Chloroquine.

Unit IV Industrial products in daily life
Soaps & Detergents: Structures and methods of use of soaps and detergents. Paints, emulsions and Pigments: White pigments. Blue, red, yellow and green pigments. Emulsion, latex; luminescent paints.

Fire retardant paints and enamels, lacquers. Solvents and thinners for paints. Dyes: Colour and constitution (electronic concept). Oils and fats: Composition of edible oils, detection of purity, rancidity of fats and oil. Tests for adulterants like aregemone oil and mineral oils. Environmental Impacts.

Unit V: Culinary Molecules

Food additives, adulterants and contaminants- Food preservatives like benzoates, propionates, sorbates, disulphites. Artificial sweeteners, Flavours and Artificial food colorants, Fermentation process in food industry, Dairy Products- Composition of milk and milk products, Estimation of added water in milk.

REFERENCES:

1. *B. R. Puri, L. R. Sharma, Kalia, 'Principles of Inorganic Chemistry', VishalPublishing Co., 2008*
2. *Food Chemistry Lilian Hoagland Meyer, CBS publisher.*
3. *P. C. Jain and Monika Jain, "Engineering Chemistry" Dhanpat Rai PublishingCompany (P) LTD, New Delhi, 2015*
4. *Thomas. E. Furia, "Handbook of food additives" 2nd Edition, Volume 2, CRCpress, 1980 2. P. Bailey. A.E." Industrial oils and Fat products'' Inter science Publishers*

❖ List of Minor Papers:

❖ Minor in Chemical Computing

Semester 3

25CHY231 Scientific Computing using Python + Lab 3 1 1 4

Unit 1 - Programming in Python

Python programming style – Plotting – Data input/output – Error analysis and non-dimensionalization – Lagrange Interpolation - Splines

Unit 2 - Numerical Algorithms

Numerical Integration – Newton Cotes – Gaussian quadrature – Differentiation – ODE solvers – Eulers Method – Fourier Transforms

Unit 3 - Data analysis and visualization (Matplotlib)

Generating Data – Plotting a simple line graph – Random walks – Rolling Dice – customizing plots – visualizing distributions with histograms – techniques for handling skewed data -

Unit 4 – Introduction to NumPy

Introduction to NumPy – Computing using formulas - Vectorization – Broadcast - Identify matrix – Indexing and Slicing — Fancy Array – Reduction Operation – Random Numbers and histograms – Linear Algebra method walkthrough – PCA Implementation

Unit 4 – Introduction to SciPy

Clustering algorithms – Physical and mathematical constants – Fast Fourier transform routines – integrate – interpolate – optimize – signal processing – sparse matrices and associated routines

Lab

Use NumPy to perform numerical linear algebra operations.

Use SciPy to solve a differential equation.

Use Matplotlib to visualize data.

Use a scientific computing library to perform a specific scientific computing task, such as computing the Fourier transform of a signal or finding the eigenvalues of a matrix.

Reference:

1. *Scientific Computing with Python* by Eric Jones, Travis Oliphant, and Pearu Peterson
2. Numerical Python: A Practical Techniques Approach for Industry, Robert Johansson

Semester 4

25CHY241 Machine Learning and AI + Lab 3 1 1 4

Unit-1 AI Introduction Perceptron, Multi-Layer perceptron, Markov Decision Process, Logical Agent & First Order Logic, AL Applications

Unit-2 Supervised & Unsupervised Learning Introduction of Machine Learning, Supervised Learning, Linear Regression , Linear Equation ,Slope ,Intercept ,R square value , Logistic regression , ODDS ratio, Probability of success, Probability of failure Bias Variance Tradeoff , ROC curve, Bias Variance Tradeoff, K-Means , K-Means ++ , Hierarchical Clustering.

Unit-3 Other Machine Learning Algorithms K – Nearest Neighbour, Naïve Bayes Classifier, Decision Tree – CART, Decision Tree – C50, Random Forest.

Unit-4 Deep Learning Deep Learning Algorithms, CNN – Convolutional Neural Network, RNN – Recurrent Neural Network, ANN – Artificial Neural Network

Unit-5 Applications and Future Challenges, AI in Chemistry, Drug Discovery, Space Applications, Geoinformatics, Defence etc.

Semester 5

25CHY341 Molecules and Materials Modelling (Theory + Lab) 3 1 1 4

Unit I – Symmetry Elements and Operations

Symmetry elements – planes – axes – inversion – improper axis – Symmetry Operations and relationships – Product of Operations – Equivalence symmetry elements and operations – Naming system of notations for symmetry operations

Unit II – Molecular Symmetry and Symmetry Groups

Molecular classification using symmetry operations – Construction of molecules with idealized symmetry – Symmetry point groups – non-axial groups – cyclic groups – axial groups – special groups – cubic groups

Unit III – Point group Representations

Symmetry Representation and Characters – Multiplication table for character representation – Matrices and Symmetry Operations – Diagonal and off-diagonal Matrix elements – Significance of Trace of a matrix – Classes of Operation

Unit IV – Structure in Solids

Point symmetry Operations – Hexagonal Coordinates – Crystals systems – Lattice – Primitive unit cell – Bravais Lattices – Centering of Lattices –Wigner-Seitz and other unit cells- 2d lattices - Reciprocal Lattice - Brillouin zone

Unit V – Symmetry in Solids

Symmetry elements and operations in solid state – proper axis of rotation, mirror planes of symmetry, roto- reflection and roto-inversion axes of symmetry, screw axes of symmetry, glide planes; a brief introduction to the crystallographic point groups and space groups

Lab

Expt 1. Introduction to molecular design software (Gaussview, Spartan etc.)

Expt 2. Designing molecules and assigning point groups

Expt 3. Introduction to material design software (Materials Studio)

Expt 4. Visualization of Solid-State Structures

Expt 5. Designing 1-D, 2-D and 3-D materials

References:

1. F. Albert Cotton, 'Chemical Applications of Group Theory', 3rd Edition, John Wiley, 1990.
2. A Salahuddin Kunju, G Krishnan; 'Group theory and its application in chemistry', second edition, PHI Learning private limited-2015
3. Robert L Carter, 'Molecular symmetry and Group theory', John Wiley & Sons, Inc.
4. V. Ramakrishnan and M.S. Gopinathan, 'Group Theory in Chemistry', 2nd reprint edition, Vishal Publications, 1996.
5. P.H. Walton, "Beginning Group Theory for Chemistry", Oxford University Press Inc., New York, 1998.

Semester 6

25CHY351 Applied Computations (Theory) 3 1 0 4

Unit I – Introduction to Computational Chemistry

Tools of Computational Chemistry – Potential Energy Surfaces - Basis Sets - Classification of Basis sets – Contracted Basis Sets – Different types – Plane wave basis functions – Effective Core Potential (ECP) – Basis set superposition Error (BSSE) – Importance of symmetry - Predicting Molecular Geometry – Level of theory

Unit II – Ab-Initio Methods

Hartree-Fock Approximation - Electron correlation – Møller-Plesset Perturbation Theory - Configuration Interaction (CI) – Truncated and Direct CI – Multiconfiguration SCF – Complete Active Space SCF – Multi Reference CI – Many body
perturbation theory – Coupled Cluster Methods

Unit III – Density Functional Theory

Introduction – Postulates - Kohn-Sham Theory – Exchange and Correlation holes – Exchange-Correlation Functionals – Local Density Approximation (LDA), Gradient-corrected Methods – Advantages and Disadvantages of DFT over MO Theory

Unit IV – Molecular Mechanics and Dynamics

Fundamental assumptions – Potential energy functional forms – Force field energies – Thermodynamics – Docking – Molecular Dynamics – Simulations of Molecules – Simulations of liquids – hybrid QM/MM methods

Unit V – Computations on Materials

Schrodinger's Equation – Periodic Potentials - Bloch Functions – Basis sets – All-electron basis, Atomic-basis, Plane-wave basis – Psuedopotentials – Norm-conserving, ultrasoft, PAW - Exchange and Correlation - Density Functional Theory - Approximations – LDA and GGA

25CHY386 Applied Computations (Lab) 0 0 6 2

Expt 1. Geometry Optimization and Vibrational Analysis (Gaussian)

Expt 2. Analysis and Visualization of computed output (Gaussview)

Expt 3. Interaction and correlation Diagrams from Extended Huckel calculations (CACAO/YaeHMOP/Avogadro)[f]

Expt 4. Geometry Optimization and phonon calculations of Periodic Networks (Materials Studio)

Expt 5. Analysis of Bands, DOS and COOP (YaeHMOP/Avogadro)[f]

Expt 6. Molecular Dynamics Simulations

Expt 7. Docking Studies

References:

1.Ira N. Levin, 'Quantum Chemistry', 6th Edition, Prentice-Hall, 2008
2. Frank Jensen, 'Introduction to Computational Chemistry', 2nd edition, Wiley, 2013
3. John P. Lowe, K. Peterson, 'Quantum Chemistry', 3rd edition, Elsevier Science, 2011
4. Donald A. McQuarrie, 'Quantum Chemistry', Viva Books2016.
5. Szabo & Ostlund, "Modern Quantum Chemistry", Dover Publications

❖ Minor in Forensic Data Science

Semester 3

25CHY232 Introduction to Forensic Science and Crime Scene Investigation 3 1 0 4

Unit 1: Introduction to Forensic Science

Introduction, History and Development of Forensic Science, Scope, Concepts and Significance of Forensic Science, Basic principles of Forensic Science, Branches of forensic science, Role of forensic science in criminal justice, Organizational set-up of a Forensic Science Laboratory, Basic principles of analytical chemistry

Unit 2: Analysis Techniques in Forensic Science:

Basic Principles: Microscopy, spectroscopy, chromatography-instrumentation &Forensic application **Analytical Methods:** Electrophoresis, Enzyme-Linked Immunosorbent Assay (ELISA), Radioimmunoassay (RIA)-Forensic Application-**Research Methodologies:** Formation of research

designs for specific problems, central tendency and dispersion, test of significance, analysis of variance, correlation and regression.

Unit 3: Crime Scene Management and Evidence Collection

Principles of crime scene management,Types of crime scenes,Documentation and chain of custody,**Chemistry Background**:Introduction to chemical safety and protocols in crime scene management,Types of evidence (biological, chemical, physical),Techniques for evidence collection and preservation, Tools and equipment used at crime scenes,**Chemistry Background**: Chemical properties and reactions relevant to evidence collection

Unit 4: Forensic Photography and Sketching

Fundamentals of forensic photography, Techniques of black & white and color photography, Photogrammetry and 3D crime scene reconstruction; exposing, development and printing techniques; Crime scene sketching techniques; Different kinds of developers and fixers; UV, IR, fluorescence illumination guided photography; Modern development in photography- digital photography, working and basic principles of digital photography; Surveillance photography. Videography and Crime Scene & laboratory photography.

Unit 5: Introduction to Forensic Laboratory

Overview of Forensic Laboratories; Safety Protocols in Forensic Laboratories; Introduction to Laboratory Equipment and Their Chemical Applications; Spectrophotometers, Gas Chromatography-Mass Spectrometry (GC-MS), High Performance Liquid Chromatography (HPLC), Fourier Transform Infrared Spectroscopy (FTIR), DNA Sequencers

Textbook recommendations

1. Bell, S. "Forensic Science: An Introduction to Scientific and Investigative Techniques". CRC Press.
2. Geberth, V. J. "Crime Scene Investigation: A Guide for Law Enforcement". CRC Press.
3. Saferstein, R. "Forensic Science: From the Crime Scene to the Crime Lab". Prentice
4. Robinson, E. M. "Crime Scene Photography". Academic Press.
5. Byrd, J. E., & Cruse, A. M. "Forensic Science: Laboratory Manual and Workbook". Pearson.

Semester 4

25CHY242 Forensic Document Examination and Digital Forensics 3 1 0 4

Unit 1: Forensic Document Examination

Handwriting analysis, Detection of forgeries and alterations, Examination of questioned documents, Chemical techniques for document analysis (e.g., ink analysis), Ink Age Determination, Paper Analysis and Authentication, Digital Document Examination, Typewriting and Printing Process Analysis, Detection of Erasures and Obliterations, Watermark and Security Features Analysis, Case Studies in Document Examination

Unit 2: Digital Forensics

Basics of digital forensics, Techniques for data recovery and analysis, Legal aspects of digital evidence, Introduction to cyber security and data encryption, Network Forensics, Mobile Device

Forensics, Forensic Analysis of Email and Messaging Systems, Cloud Forensics, Incident Response and Management, Malware Analysis and Reverse Engineering, Forensic Examination of Internet Artifacts

Unit 3: Forensic Ballistics

Firearms and ammunition identification, Gunshot residue analysis, Trajectory reconstruction, Chemical composition and analysis of explosives and gunshot residues, Bullet and Cartridge Case Examination, Forensic Examination of Tool Marks on Firearms, Ballistic Gelatin Testing, Ballistic Wound Analysis, Terminal Ballistics, Exterior Ballistics, Forensic Comparison Microscopy, Forensic Ballistics Case Studies

Unit 4: Forensic Audio and Video Analysis

Analysis of audio recordings, Enhancement of video footage, Techniques for authenticity verification, Chemical techniques in the analysis of audio and video tapes, Voice Identification and Speaker Recognition, Spectral Analysis of Audio Signals, Noise Reduction and Audio Cleaning Techniques, Authentication of Digital Audio and Video Files, Analysis of Encrypted and Compressed Media Files, Waveform Analysis and Digital Signal Processing, Techniques for Restoring Damaged Tapes, Forensic Imaging and Frame-by-Frame Analysis, Legal Admissibility of Audio and Video Evidence, Forensic Case Studies in Audio and Video Analysis

Unit 5: Ethics and Professionalism in Forensic Science

Ethical issues in forensic science, Professional standards and practices, Case studies and real-world applications, Ethical considerations in chemical research and applications, Confidentiality and Privacy in Forensic Investigations, Conflict of Interest in Forensic Science, Responsibilities of Expert Witnesses, Ethical Issues in Forensic Report Writing and Testimony, Professional Accountability and Integrity in Forensic Practice, Global Standards and Cross-Cultural Ethical Considerations in Forensics

References

1. Ellen, D. "The Scientific Examination of Documents: Methods and Techniques". CRC Press.
2. Casey, E. "Handbook of Digital Forensics and Investigation". Academic Press.
3. Heard, B. J. "Handbook of Firearms and Ballistics: Examining and Interpreting Forensic Evid ence". John Wiley & Sons.
4. Koenig, B. E. "Spectral Audio Signal Processing". W. W. Norton & Company.
5. Gehl, R. & Plecas, D. "Introduction to Professional Ethics in Forensic Science". CRC Press.

Semester 5

25CHY342 Forensic Chemistry and Toxicology 3 1 0 4

Unit 1: Introduction to Forensic Chemistry

Principles and applications of Gas Chromatography-Mass Spectrometry (GC-MS), High-Performance Liquid Chromatography (HPLC), Atomic Absorption Spectroscopy (AAS), X-ray Diffraction (XRD),Scanning Electron Microscopy (SEM) and Energy Dispersive X-ray Analysis (EDX); Basics of stoichiometry, Chemical equilibria and kinetics, Acid-base titrations and buffer systems,

Gravimetric and volumetric analysis, Error analysis and statistical treatment of analytical data Forensic Toxicology, Trace Evidence Analysis, Forensic Soil Analysis, Explosive and Fire Debris Analysis, Environmental Forensics

Unit 2: Forensic Toxicology

Principles of Toxicology; Types of Toxins and Poisons, Immunoassays, Mass Spectrometry, Chemical Structure and Properties of Common Toxins, Structure-Activity Relationships (SAR), Toxicokinetics of Specific Toxins, Forensic Toxicology in Court, Clinical Toxicology, Environmental Toxicology: Impact of toxins on the environment and public health, Pesticides and Herbicides, Drug-Facilitated Crimes

Unit 3: Drug Analysis

Classification of drugs, Analytical methods for drug identification, Legal aspects of drug analysis, Drug Metabolism and Pharmacokinetics, Forensic Toxicology of Drugs, Emerging Drug Trends, Forensic Analysis of Drug Impurities, Case Studies in Drug Analysis

Unit 4: Alcohol and Breath Analysis

Chemistry of alcohol metabolism, Techniques for detecting alcohol in breath and blood, Legal implications of alcohol analysis, Chemical reactions involved in alcohol metabolism and detection, Instrumentation for Alcohol Detection, Alcohol Impairment and Its Effects, Forensic Analysis of Alcohol Levels in Postmortem Samples, Advances in Non-Invasive Alcohol Detection Methods, Case Studies in Alcohol Analysis

Unit 5: Forensic Chromatography

Types of chromatography (GC, HPLC, TLC), Applications in forensic science, Case studies involving chromatography, Optimization of Chromatographic Conditions, Detection Methods in Chromatography, Sample Preparation Techniques, High-Performance Thin-Layer Chromatography (HPTLC), Quantitative Chromatographic Analysis

Text Books

1. Dean, J. R. "Forensic Chemistry". John Wiley & Sons.
2. Levine, B. "Principles of Forensic Toxicology". Springer.
3. Clark, C. C. "Handbook of Forensic Drug Analysis". Elsevier.
4. Borkenstein, R. F. "Alcohol, Drugs, and Human Performance". Institute of Police Technolog y and Management.
5. Gennaro, M. C. "Chromatography and Analysis of Pharmaceuticals". Springer.

Semester 6

25CHY353 Forensic Biology and DNA Analysis 3 1 0 4

Unit 1: Forensic Biology

Biological evidence in forensic investigations, Collection and preservation of biological samples, Microscopy and histology techniques, Biochemical principles and techniques, Genetic Profiling and

DNA Fingerprinting, Forensic Botany and Palynology, Forensic Odontology, Forensic Microbiology, Forensic Entomology

Unit 2: DNA Analysis

Basics of DNA structure and function, Techniques for DNA extraction and quantification, Polymerase Chain Reaction (PCR) and STR analysis, Chemical basis of DNA extraction and amplification, DNA Sequencing Technologies, Mitochondrial DNA (mtDNA) Analysis, Y-Chromosome Analysis, DNA Databases and CODIS, Ethical and Legal Considerations in DNA Analysis

Unit 3: Forensic Serology

Blood, semen, and saliva identification, Bloodstain pattern analysis, Immunological techniques in serology, Chemistry of blood and other body fluids, Techniques for Serological Testing, Forensic Analysis of Menstrual Blood, Saliva and Urine Identification, Seminal Fluid Analysis, Case Studies in Forensic Serology

Unit 4: Forensic Entomology

Role of insects in forensic investigations, Estimation of time since death using insect evidence, Collection and preservation of entomological evidence, Chemical methods in entomology, Identification of Insect Species in Forensics, Ecological Succession of Insects on Cadavers, Insect Developmental Stages and Forensic Analysis, Applications of Forensic Entomology in Urban Cases, Impact of Environmental Factors on Forensic Entomology, Forensic Entomology Case Studies

Unit 5: Forensic Anthropology

Identification of human remains, Skeletal analysis and age estimation, Facial reconstruction techniques, Chemical analysis of bones and skeletal remains, Sex Estimation from Skeletal Remains, Stature Reconstruction from Bones, Forensic Taphonomy, Analysis of Trauma and Pathology in Bones, Techniques for Identifying Ancestry from Skeletal Traits, Bone Histology in Forensic Investigations, Case Studies in Forensic Anthropology

Text Books

1. Li, R. "Forensic Biology". CRC Press.
2. Butler, J. M. "Forensic DNA Typing: Biology, Technology, and Genetics of STR Markers". Academic Press.
3. Li, R. A., & Jamieson, A. "Forensic Serology: Principles and Applications". CRC Press.
4. Goff, M. L. "A Fly for the Prosecution: How Insect Evidence Helps Solve Crimes". Harvard University Press.
5. Byers, S. N. "Introduction to Forensic Anthropology". Pearson.

25CHY387 Forensic Science & Documentation Lab 0 0 6 2

1. To determine the concentration of a colored compound by colorimetry analysis.
2. To carry out thin layer chromatography of ink samples.
3. To carry out separation of organic compounds by paper chromatography.

4. To identify drug samples using UV-Visible spectroscopy.
5. To take photographs using different filter.
6. To record videography of a crime scene. To compare paint samples by thin layer chromatography method.
7. To identify handwriting characters.
8. To study natural variations in handwriting.
9. To compare handwriting samples.
10. To detect simulated forgery.
11. To detect traced forgery.

Text Books

1. D.A. Skoog, D.M. West and F.J. Holler, Fundamentals of Analytical Chemistry, 6 th Edition, Saunders College Publishing, Fort Worth (1992).
2. W. Kemp, Organic Spectroscopy, 3rd Edition, Macmillan, Hampshire (1991).
3. J.W. Robinson, Undergraduate Instrumental Analysis, 5th Edition, Marcel Dekker, Inc., New York (1995).
4. D.R. Redsicker, The Practical Methodology of Forensic Photography, 2nd Edition, CRC Press, Boca Raton (2000). O. Hilton, Scientific Examination of Questioned Documents, CRC Press, Boca Raton (1982).
5. A.A. Moenssens, J. Starrs, C.E. Henderson and F.E. Inbau, Scientific Evidence in Civil and Criminal Cases, 4th Edition, Foundation Press, New York (1995).
6. R.N. Morris, Forensic Handwriting Identification: Fundamental Concepts and Principles, Academic Press, London (2000).
7. E. David, The Scientific Examination of Documents – Methods and Techniques, 2nd Edition, Taylor & Francis.

❖ Minor in Industrial Pharmaceutics

Semester 3

25CHY233 Introduction to Pharmaceutical Chemistry 3 1 0 4

1. Course Overview

Introduction to Medicinal Chemistry is a course offered to 4-year B.Sc. (Honours) with/without Research and 5-year Integrated M.Sc. students in the department of chemistry. This course is curated to introduce concepts pharmaceutical chemistry, receptors, enzymes, and other drug targets.

2. Course Outcome

CO1: To understand basic concepts of pharmaceutical chemistry.
CO2: To elucidate the effect of structure and functional groups of the drug on drug-target interaction.
CO3: To explain the thermodynamic and energy parameters of drug action
CO4: To predict stereochemical aspects of drug-target interaction.
CO5: To evaluate the effect of structure and functional groups on drug metabolism.

3. Course Syllabus

Unit 1: Introduction to Pharmaceutical Chemistry (10 Hrs)

Introduction to Pharmaceuticals, Historical development, Classification drugs, Nomenclature of Pharmaceuticals.

Drug discovery and development process, Sequence of events after drug administration, List of physico-chemical properties related to drug action, Clinical Chemistry and the importance of fundamental chemistry concepts and analytical techniques

Unit 2: Drug-Target Interactions (8 Hrs)

Structural Effects on Biological Action, Role and types of chemical bonding interactions between drug and target, binding of neurotransmitters to their receptors, Solubility, partition coefficient, dissociation constant, hydrogen bonding, ionization, drug shape, surface activity, complexation, protein binding, molar refractivity**.**

Enzyme, receptors, nuclei acid, protein, lipid as drug targets.

Unit 3: Basics of Drug Action (8 Hrs)

Energy: Energy concept and its importance in drug action. First, Second and Third laws of thermodynamics and the principles derived from these laws which are of significance to drug action.

Thermodynamics: Free energy and Relationship between thermodynamics and statistics. Importance of chemical potential in drug action. Thermodynamic cycle. Statistical thermodynamics in predicting the structure of biomolecules and their interaction with drug molecules. Macromolecular vs. micromolecular correlation using thermodynamics and statistical thermodynamics.

Unit 4: Influence of Stereochemistry on Drug Action (8 Hrs)

Stereoisomers, Stereochemistry of unsaturated compounds, Enantiomers, Diastereomers, Partition coefficients.

Bioisosterism – stereochemical aspects of drug action, Realization that stereoselectivity is a pre-requisite for evolution; Role selective and specific therapeutic agents; Case studies; Enantioselectivity in drug absorption, metabolism, distribution and elimination

Unit 5: Chemical Aspects of Drug Metabolism (8 Hrs)

Introduction, Effects of chemical structure on Phase I oxidative, reductive, and hydrolytic reactions, Effects of chemical structure on phase II conjugative reactions (COMT and PNMT-catalyzed methylation, acetylation, sulfation, glucuronidation, amino acid conjugation, mercapturic acid formation), Sites of metabolism, Metabolic pathways of selected common drugs, Metabolites identified for a new anticancer drug, Imatinib.

References

1. *The Organic Chemistry of Drug Design and Drug Action by R.B. Silverman*
2. *C.J. Coulson, Molecular Mechanism of Drug Action by C.J. Coulson*
3. *A primer of Drug Action by R.M. Julien*
4. *Drug-Receptor Thermodynamics by R.B. Raffa*
5. *Principles of Drug Action by W.B. Pratt, P. Taylor*
6. *Organic Chemistry Concepts and Applications for Medicinal Chemistry, Joseph E. Rice, Academic Press, 2014, Softcover; ISBN 9780128007396 or eBook; ISBN 9780128008324*

Semester 4

25CHY243 Essentials of Drug Design 3 1 0 4

1. Course Overview

Essentials of Drug Design is a course offered to 4-year B.Sc. (Honours) with/without Research and 5-year Integrated M.Sc. students in the department of chemistry. This course is curated to introduce the concepts and requirements for the designing of drug molecules.

2. Course Outcome

CO1: To explore the principles and development of drug design
CO2: To analyze the mechanisms of drug-receptor interactions
CO3: To apply QSAR principles to enhance drug design
CO4: To utilize computers to advance drug design
CO5: To integrate pharmacokinetics into drug design

3. Course Syllabus

Unit 1: Introduction to Drug Design and Its Development (8 Hrs)

Definition, history (chronological evolution), drug design approaches, lead optimization, de Novo drug design, various sources of new drugs, leads from natural products, molecular modifications, random screening, high throughput screening, *insilico* screening, structural features and pharmacological activity, prodrugs, soft drugs.

Unit 2: Drug-Receptor Interactions (10 Hrs)

Historical background, receptor theories, forces involved in drug receptor interactions, covalent & non-covalent interactions, agonist and antagonists, introduction and general principles of route of drug administration, pharmacokinetics (absorption, distribution, metabolism and excretion), specific and non-

specific drug action, concept of receptors, drug-receptor interactions, receptor theories, ion-channels and membrane-bound enzymes.

Unit 3: QSAR in Drug Design (10 Hrs)

Parameters and biological data for QSAR, design of test series in QSAR, Craig plot, assessment of drug activity, mechanism of drug action, drug metabolism pathways, drug potentiation, drug antagonism and drug resistance, molecular mimetics, drug-lead modification, drug design using QSAR and computer assisted design,

Unit 4: Computers in Drug Design (10 Hrs)

Introduction, data base and information retrieval techniques, computer graphics and molecular visualization, molecular interactions and interactive graphics, computational chemistry overview, force field methods, geometry optimization, conformational searching.

Introduction to molecular mechanics, molecular dynamics & quantum mechanics (semiempirical & ab initio methods), molecular dynamics simulations, modelling in medicinal chemistry-uses and limitations, logical structural approaches, activity profile selection, structure-based drug design and pharmacophore perception, predictive ADME.

Unit 5: Pharmacokinetics in Drug Designing (10 Hrs)

Introduction, absorption, distribution, metabolism and excretion of drugs, principles of pharmacokinetics, environmental pharmacokinetics, single and two compartment pharmacokinetics, pharmacokinetics of drug metabolism, dissection of a drug molecule into bifunctional moieties, modulation of pharmacokinetics by molecular manipulations, Lipinski's rule, QSPR, biopharmaceutics, generic equivalence and non-equivalence, role of biopharmaceutics in drug designing, bioavailability and bioequivalence, pharmacogenetics, adverse drug reaction, drug interactions, bioassays and preclinical studies, clinical trials.

References:

1. Wilson and Gisvold's textbook of pharmaceutical organic medicinal chemistry
2. Foye's principles of medicinal chemistry
3. Burger's medicinal chemistry and drug discovery
4. Organic chemistry of synthetic drugs – Lednier
5. The Organic Chemistry of Drug Design and Drug Action. by R.B. Silverman, Academic Press,1992
6. Drug Designs- A series of monographs in medicinal chemistry edited by A.J. Ariens
7. Comprehensive medicinal chemistry. Peragmon Press. 1990, Vol.4.
8. Pharmacological Basis of Therapeutics by Goodman & Gillman
9. Pharmacology and pharmacotherapeutics by Satoshkar & Bhandarkar
10. Principles of Pharmacology by Sharma & Sharma

Semester 5

25CHY343 Pharmacotherapeutic Compounds 3 1 0 4

1. Course Overview

Pharmacotherapeutic Compounds is a course offered to 4-year B.Sc. (Honours) with/without Research and 5-year Integrated M.Sc. students in the department of chemistry. This course is curated to introduce various types of medicinal agents used to treat different diseases.

2. Course Outcome

CO1: To explore medicinal agents derived from natural products
CO2: To examine the various classes of medicinal agents
CO3: To examine the causes and effects of infectious and non-infectious diseases

3. Course Syllabus

Unit 1: Medicinal agents from natural products (10 Hrs)

History of the use of natural products as therapeutic agents, medicinal plants, active principle, isolation methods of alkaloids and terpenes, antioxidants, natural oils from plants.

Unit 2: Classes of Medicinal Agents – I (10 Hrs)

Medicinal agents belonging to alkaloids, steroids, polypeptides, modified nucleic acid bases, sulphonamide and sulpha drugs, antibacterials - sulpha drugs, substituted sulphonamides.

Unit 3 Classes of Medicinal Agents – II (10 Hrs)

Anticonvulsants, anticoagulants, antiamoebic agents, antihelmintic agents, anti-malarial agents, diuretics and cardiovascular agents.

Unit 4: Medicinal agents affecting CNS (10 Hrs)

Medicinal agents affecting CNS: analgesics, antipyretics, antiseptics and disinfectants, histamine and anti-histaminic agents.

Unit 5: Infectious and non-infectious diseases (8 Hrs)

Infectious and non-infectious diseases (malaria, AIDS, cancer) - introduction, mechanism of action, types of cures.

References:

1. A. Burger, 'Medicinal Chemistry', 3rd edition, Wiley Interscience, 1970.
2. V. K. Ahluwalia and Madhu Chopra, 'Medicinal Chemistry', Ane Books pvt Ltd, 2008.
3. V. Kothekar, 'Essentials of Drug Designing', 14th edition, Dhruv publications, 2005.
4. V. K. Ahluwalia, Lalita S. Kumar and Sanjiv Kumar, 'Chemistry of Natural Products', Ane Books India.
5. L. P. Graham 'An introduction to Medicinal Chemistry', 3rd edition, Oxford University Press, 2005.

Semester 6

25CHY355 Drug Development and Marketing 3 1 0 4

2. Course Overview

Drug Development and Marketing is a course offered to 4-year B.Sc. (Honours) with/without Research and 5-year Integrated M.Sc. students in the department of chemistry. This course is curated to introduce some of the latest industrial techniques for identification and purification of drugs, steps of marketing a drug,

and toxicology studies. Further this course also projects some recent case studies of drug design and development to give a real-time exposure to the students.

2. Course Outcome

CO1: To develop materials with pharmaceutical significance.

CO2: To validate the applicability of specific pharmaceuticals in physiological environment.

CO3: To scale-up the production of pharmaceutical materials.

CO4: To estimate the purity level of the drugs.

CO5: To evaluate the drug action with real-time studies.

3. Course Syllabus

Unit 1: Preformulation and Optimization (10 Hrs)

Drug Excipient interactions: different methods, kinetics of stability, Stability testing. Theories of dispersion and pharmaceutical Dispersion (Emulsion and Suspension, SMEDDS) preparation and stability Large and small volume parental– physiological and formulation consideration, Manufacturing and evaluation.

Optimization techniques in Pharmaceutical Formulation: Concept and parameters of optimization, Optimization techniques in pharmaceutical formulation and processing. Statistical design, Response surface method, Contour designs, Factorial designs and application in formulation

Unit 2: Toxicity and Validation (8 Hrs)

General concepts of toxicity, acute, sub-acute & chronic toxicity tests, teratogenicity & carcinogenicity, LD50, ED50, MIC- anti infectives, habituation & addiction.

Introduction to Pharmaceutical Validation, Scope & merits of Validation, Validation and calibration of Master plan, ICH & WHO guidelines for calibration and validation of equipments, Validation of specific dosage form, Types of validation. Government regulation, Manufacturing Process Model, URS, DQ, IQ, OQ & P.Q. of facilities.

Study of consolidation parameters: Diffusion parameters, Dissolution parameters and Pharmacokinetic parameters, Heckel plots, Similarity factors – f2 and f1, Higuchi and Peppas plot, Linearity Concept of significance, Standard deviation, Chi square test, students T-test, ANOVA test.

Unit 3: Modern Pharmaceutical Analytical Techniques (8 Hrs)

Chromatographic methods: Principle, apparatus, instrumentation, chromatographic parameters, factors affecting resolution and applications of the following: a) Paper chromatography b) Thin Layer chromatography c) Ion exchange chromatography d) Column chromatography e) Gas chromatography f) High Performance Liquid chromatography g) Affinity chromatography.

Flame emission spectroscopy and Atomic absorption spectroscopy: Principle, Instrumentation, Interferences and Applications.

Electrophoresis: Principle, Instrumentation, working conditions, factors affecting separation and applications of the following: a) Paper electrophoresis b) Gel electrophoresis c) Capillary electrophoresis d) Zone electrophoresis e) Moving boundary electrophoresis f) Isoelectric focusing.

Immunological Assays: Radioimmunology assay (RIA), ELISA (Theory & practical) and knowledge on Bioluminescence assays.

Unit 4: Marketing the Drug (8 Hrs)

Preclinical and clinical trials, Toxicity testing, Drug metabolism studies, Pharmacology, formulation, and stability tests, Clinical trials.

Patenting and regulatory affairs, Patents, Regulatory affairs.

Chemical and process development, Chemical development, Process development, Choice of drug candidate, Natural products.

Unit 5: Specific Case Studies **(6 Hrs)**

Case study 1: The design of angiotensin converting enzyme (ACE) inhibitors

Case study 2: The design of oxamniquine

Case study 3: Discovery of Boceprevir: Treatment of Hepatitis C Virus Infection

References

1. *Theory and Practice of Industrial Pharmacy By Lachmann and Libermann*
2. *Pharmaceutical dosage forms: Tablets Vol. 1-3 by Leon Lachmann*
3. *Pharmaceutical Dosage forms: Disperse systems, Vol, 1-2; By Leon Lachmann*
4. *Pharmaceutical Dosage forms: Parenteral medications Vol. 1-2; By Leon Lachmann*
5. *Modern Pharmaceutics; By Gillbert and S. Banker.*
6. *Remington"s Pharmaceutical Sciences.*
7. *Advances in Pharmaceutical Sciences Vol. 1-5; By H.S. Bean & A.H. Beckett.*
8. *Physical Pharmacy; By Alfred martin.*
9. *Bentley"s Textbook of Pharmaceutics – by Rawlins.*
10. *Good manufacturing practices for Pharmaceuticals: A plan for total quality control, Second edition; By Sidney H. Willig.*
11. *Quality Assurance Guide; By Organization of Pharmaceutical producers of India.*
12. *Drug formulation manual; By D.P.S. Kohli and D.H.Shah. Eastern publishers, New Delhi.*
13. *How to practice GMPs; By P.P.Sharma. Vandhana Publications, Agra.*
14. *Pharmaceutical Process Validation; By Fra. R. Berry and Robert A. Nash.*
15. *Pharmaceutical Preformulations; By J.J. Wells.*
16. *Applied production and operations management; By Evans, Anderson, Sweeney and Williams.*

25CHY388 Medicinal Chemistry (Lab) 0 0 6 2

I Preparation of drugs/ intermediates

1. 1,3-pyrazole
2. 1,3-oxazole
3. Benzimidazole
4. Benztriazole 5
5. 2,3- diphenyl quinoxaline 6 7 8 9 II
6. Benzocaine
7. Phenytoin
8. Phenothiazine
9. Barbiturate

II. Assay of drugs

1. Chlorpromazine
2. Phenobarbitone
3. Atropine
4. Ibuprofen
5. Aspirin
6. Furosemide

III. Determination of Partition coefficient for any two drugs

Recommended Books (Latest Editions)

1. Wilson and Giswold's Organic medicinal and Pharmaceutical Chemistry.
2. Foye's Principles of Medicinal Chemistry.
3. Burger's Medicinal Chemistry, Vol I to IV.
4. Introduction to principles of drug design- Smith and Williams.
5. Remington's Pharmaceutical Sciences.
6. Martindale's extra pharmacopoeia.

AMRITA VALUE PROGRAMMES I & II

22AVP201 Message from Amma's Life for the Modern World

Amma's messages can be put to action in our life through pragmatism and attuning of our thought process in a positive and creative manner. Every single word Amma speaks and the guidance received in on matters which we consider as trivial are rich in content and touches the very inner being of our personality. Life gets enriched by Amma's guidance and She teaches us the art of exemplary life skills where we become witness to all the happenings around us still keeping the balance of the mind.

22ADM211 Leadership from the Ramayana

Introduction to Ramayana, the first Epic in the world – Influence of Ramayana on Indian values and culture – Storyline of Ramayana – Study of leading characters in Ramayana – Influence of Ramayana outside India – Relevance of Ramayana for modern times.

22ADM201 Strategic Lessons from the Mahabharata

Introduction to Mahabharata, the largest Epic in the world – Influence of Mahabharata on Indian values and culture – Storyline of Mahabharata – Study of leading characters in Mahabharata – Kurukshetra War and its significance - Relevance of Mahabharata for modern times.

22AVP204 Lessons from the Upanishads

Introduction to the Upanishads: Sruti versus Smrti - Overview of the four Vedas and the ten Principal Upanishads - The central problems of the Upanishads – The Upanishads and Indian Culture – Relevance of Upanishads for modern times – A few Upanishad Personalities: Nachiketas, SatyakamaJabala, Aruni, Shvetaketu.

22AVP205 Message of the Bhagavad Gita

Introduction to Bhagavad Gita – Brief storyline of Mahabharata - Context of Kurukshetra War – The anguish of Arjuna – Counsel by Sri. Krishna – Key teachings of the Bhagavad Gita – Karma Yoga, Jnana Yoga and Bhakti Yoga - Theory of Karma and Reincarnation – Concept of Dharma – Concept of Avatar - Relevance of Mahabharata for modern times.

22AVP206 Life and Message of Swami Vivekananda

Brief Sketch of Swami Vivekananda's Life – Meeting with Guru – Disciplining of Narendra - Travel across India - Inspiring Life incidents – Address at the Parliament of Religions – Travel in United States and Europe – Return and reception India – Message from Swamiji's life.

22AVP207 Life and Teachings of Spiritual Masters India

Sri Rama, Sri Krishna, Sri Buddha, AdiShankaracharya, Sri Ramakrishna Paramahamsa, Swami Vivekananda, Sri RamanaMaharshi, Mata Amritanandamayi Devi.

22AVP208 Insights into Indian Arts and Literature

The aim of this course is to present the rich literature and culture of Ancient India and help students appreciate their deep influence on Indian Life - Vedic culture, primary source of Indian Culture – Brief introduction and appreciation of a few of the art forms of India - Arts, Music, Dance, Theatre.

22AVP209 Yoga and Meditation

The objective of the course is to provide practical training in YOGA ASANAS with a sound theoretical base and theory classes on selected verses of Patanjali's Yoga Sutra and Ashtanga Yoga. The coverage also includes the effect of yoga on integrated personality development.

22AVP210 Kerala Mural Art and Painting

Mural painting is an offshoot of the devotional tradition of Kerala. A mural is any piece of artwork painted or applied directly on a wall, ceiling or other large permanent surface. In the contemporary scenario Mural painting is not restricted to the permanent structures and are being done even on canvas. Kerala mural paintings are the frescos depicting mythology and legends, which are drawn on the walls of temples and churches in South India, principally in Kerala. Ancient temples, churches and places in Kerala, South India, display an abounding tradition of mural paintings mostly dating back between the 9th to 12th centuries when this form of art enjoyed Royal patronage. Learning Mural painting through the theory and practice workshop is the objective of this course.

22AVP213 Traditional Fine Arts of India

India is home to one of the most diverse Art forms world over. The underlying philosophy of Indian life is 'Únity in Diversity" and it has led to the most diverse expressions of culture in India. Most art forms of India are an expression of devotion by the devotee towards the Lord and its influence in Indian life is very pervasive. This course will introduce students to the deeper philosophical basis of Indian Art forms and attempt to provide a practical demonstration of the continuing relevance of the Art.

22AVP214 Principles of Worship in India

Indian mode of worship is unique among the world civilizations. Nowhere in the world has the philosophical idea of reverence and worshipfulness for everything in this universe found universal acceptance as it in India. Indian religious life even today is a practical demonstration of the potential for realization of this profound truth. To see the all-pervading consciousness in everything, including animate and inanimate, and constituting society to realise this truth can be seen as the epitome of civilizational excellence. This course will discuss the principles and rationale behind different modes of worship prevalent in India.

22AVP215 Temple Mural Arts in Kerala

The traditional percussion ensembles in the Temples of Kerala have enthralled millions over the years. The splendor of our temples makes art enthusiast spellbound, warmth and grandeur of color combination sumptuousness of the outline, crowding of space by divine or heroic figures often with in vigorous movement are the characteristics of murals.

The mural painting specially area visual counterpart of myth, legend, gods, dirties, and demons of the theatrical world, Identical myths are popular the birth of Rama, the story of Bhīma and Hanuman, Shiva, as Kirata, and the Jealousy of Uma and ganga the mural painting in Kerala appear to be closely related to, and influenced by this theatrical activity the art historians on temple planes, wood carving and painting the architectural plane of the Kerala temples are built largely on the pan-Indians almost universal model of the Vasthupurusha.

22AVP218 Insights into Indian Classical Music

The course introduces the students into the various terminologies used in Indian musicology and their explanations, like Nadam, Sruti, Svaram – svara nomenclature, Stayi, Graha, Nyasa, Amsa, Thala,- Saptatalas and their angas, Shadangas, Vadi, Samavadi, Anuvadi. The course takes the students through Carnatic as well as Hindustani classical styles.

22AVP219 Insights into Traditional Indian Painting

The course introduces traditional Indian paintings in the light of ancient Indian wisdom in the fields of aesthetics, the Shadanga (Sixs limbs of Indian paintings) and the contextual stories from ancient texts from where the paintings originated. The course introduces the painting styles such as Madhubani, Kerala Mural, Pahari, Cheriyal, Rajput, Tanjore etc.

22AVP220 Insights into Indian Classical Dance

The course takes the students through the ancient Indian text on aesthetics the Natyasastra and its commentary the AbhinavaBharati. The course introduces various styles of Indian classical dance such as Bharatanatyan, Mohiniyatton, Kuchipudi, Odissy, Katak etc. The course takes the students through both contextual theory as well as practice time.

22AVP221 Indian Martial Arts and Self Defense

The course introduces the students to the ancient Indian system of self-defense and the combat through various martial art forms and focuses more on traditional Kerala's traditional KalariPayattu. The course introduces the various exercise technique to make the body supple and flexible before going into the steps and techniques of the martial art. The advanced level of this course introduces the technique of weaponry.

23LSK201 Life Skills I L-T-P-C: 1-0-2-2

Pre-requisite: An open mind and the urge for self-development, basic English language skills, knowledge of high school level mathematics.

Course Objective: To assist students in inculcating soft skills, developing a strong personality, empowering them to face life's challenges, improving their communication skills and problem-solving skills.

Course Outcomes

CO1: Soft Skills - To develop greater morale and positive attitude to face, analyze, and manage emotions in real life situations, like placement process.

CO2: Soft Skills - To empower students to create better impact on a target audience through content creation, effective delivery, appropriate body language and overcoming nervousness, in situations like presentations, Group Discussions and interviews.

CO3: Aptitude – To analyze, understand and solve questions in arithmetic and algebra by employing the most suitable methods.

CO4: Aptitude - To investigate and apply suitable techniques to solve questions on logical reasoning.

CO5: Verbal – To infer the meaning of words & use them in the right context. To have a better understanding of the nuances of English grammar and become capable of applying them effectively.

CO6: Verbal - To identify the relationship between words using reasoning skills. To develop the capacity to communicate ideas effectively.

Skills: Communication, self-confidence, emotional intelligence, presentation skills and problem-solving Skills.

CO-PO Mapping

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

Syllabus

Soft Skills

Soft Skills and its importance: Pleasure and pains of transition from an academic environment to work-environment. New-age challenges and distractions. Learning to benefit from constructive criticisms and feedback. Need for change in mindset and up-skilling to keep oneself competent in the professional world.

Managing Self: Knowing oneself, Self-perception, Importance of positive attitude, Building and displaying confidence, Avoiding being overconfident, Managing emotions, stress, fear. Developing Resilience and handling failures. Self-motivation, Self-learning, and continuous knowledge up-gradation / Life-long learning. Personal productivity - Goal setting and its importance in career planning, Self-discipline, Importance of values, ethics and integrity, Universal Human Values.

Communication: Process, Language Fluency, Non-verbal, Active listening. Assertiveness vs. aggressiveness. Barriers in communication. Digital communication

Aptitude

Numbers: Types, Power Cycles, Divisibility, Prime, Factors & Multiples, HCF & LCM, Surds, Indices, Square roots, Cube Roots and Simplification.

Percentage: Basics, Profit, Loss & Discount, and Simple & Compound Interest.

Ratio, Proportion & Variation: Basics, Alligations, Mixtures, and Partnership.

Averages: Basics, and Weighted Average.

Equations: Basics, Linear, Quadratic, Equations of Higher Degree and Problems on ages.

Logical Reasoning I: Blood Relations, Direction Test, Syllogisms, Series, Odd man out, Coding \& Decoding, Cryptarithmetic Problems and Input - Output Reasoning.

Verbal Skills

Vocabulary: Familiarize students with the etymology of words, help them realize the relevance of word analysis and enable them to answer synonym and antonym questions. Create an awareness about the frequently misused words, commonly confused words and wrong form of words in English.

Grammar (Basics): To learn the usage of grammar and facilitate students to identify errors and correct them.

Reasoning: Stress the importance of understanding the relationship between words through analogy questions. Emphasize the importance of avoiding the gap (assumption) in the argument/ statements/ communication.

Speaking Skills: Make students conscious of the relevance of effective communication in today's world through individual speaking activities.

Writing Skills: Introduce formal written communication and keep the students informed about the etiquette of email writing.

References:

1. Gulati. S., (1006) "Corporate Soft Skills", New Delhi, India: Rupa & Co.
2. The hard truth about Soft Skills, by Amazon Publication.
3. Verbal Skills Activity Book, CIR, AVVP
4. Nova's GRE Prep Course, Jeff Kolby, Scott Thornburg & Kathleen Pierce
5. The BBC and British Council online resources
6. Owl Purdue University online teaching resources
7. www.thegrammarbook.com online teaching resources
8. www.englishpage.com online teaching resources and other useful websites
9. Student Workbook: Quantitative Aptitude & Reasoning, Corporate & Industry Relations, Amrita Vishwa Vidyapeetham.
10. Quantitative Aptitude for All Competitive Examinations, Abhijit Guha.
11. How to Prepare for Quantitative Aptitude for the CAT, Arun Sharma.
12. How to Prepare for Data Interpretation for the CAT, Arun Sharma.
13. How to Prepare for Logical Reasoning for the CAT, Arun Sharma.
14. Quantitative Aptitude for Competitive Examinations, R S Aggarwal.
15. A Modern Approach to Logical Reasoning, R S Aggarwal.
16. A Modern Approach to Verbal & Non-Verbal Reasoning, R S Aggarwal.

Evaluation Pattern

Assessment	Internal	External
Continuous Assessment (CA)* – Soft Skills	30	-
Continuous Assessment (CA)* – Aptitude	10	25
Continuous Assessment (CA)* – Verbal	10	25
Total	50	50

*CA - Can be **presentations, speaking activities and tests.**

23LSK211 Life Skills II L-T-P-C: 1-0-2-2

Pre-requisite: Willingness to learn, communication skills, basic English language skills, knowledge of high school level mathematics.

Course Objective: To help students understand the corporate culture and assist them in improving their group discussion skills, communication skills, listening skills and problem-solving skills.

Course Outcomes

CO1: Soft Skills - To improve the inter-personal skills, professional etiquette and leadership skills, vital for arriving at win-win situations in Group Discussions and other team activities.
CO2: Soft Skills - To develop the ability to create better impact in a Group Discussions through examination, participation, perspective-sharing, ideation, listening, brainstorming and consensus.
CO3: Aptitude - To interpret, critically analyze and solve questions in arithmetic and algebra by employing the most suitable methods.
CO4: Aptitude - To analyze, understand and apply suitable methods to solve questions on logical reasoning.
CO5: Verbal - To be able to use vocabulary in the right context and to be competent in spotting grammatical errors and correcting them.
CO6: Verbal - To be able to logically connect words, phrases, sentences and thereby communicate their perspectives/ideas convincingly.
Skills: Communication, etiquette and grooming, inter-personal skills, listening skills, convincing skills, problem-solving skill.

CO-PO Mapping

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

Syllabus

Soft Skills

Professional Grooming and Practices: Basics of corporate culture, key pillars of business etiquette – online and offline: socially acceptable ways of behavior, body language, personal hygiene, professional attire and cultural adaptability and managing diversity. Handling pressure, multi-tasking. Being enterprising. Adapting to corporate life: Emotional Management (EQ), Adversity Management, Health consciousness. People skills, Critical Thinking and Problem solving.

Group Discussions: Advantages of group discussions, Types of group discussion and Roles played in a group discussion. Personality traits evaluated in a group discussion. Initiation techniques and maintaining the flow of the discussion, how to perform well in a group discussion. Summarization/conclusion.

Aptitude

Logarithms, Inequalities and Modulus: Basics

Sequence and Series: Basics, AP, GP, HP, and Special Series.

Time and Work: Basics, Pipes & Cistern, and Work Equivalence.

Time, Speed and Distance: Basics, Average Speed, Relative Speed, Boats & Streams, Races and Circular tracks.

Logical Reasoning II: Arrangements, Sequencing, Scheduling, Venn Diagram, Network Diagrams, Binary Logic, and Logical Connectives, Clocks, Calendars, Cubes, Non-Verbal reasoning and Symbol based reasoning.

Verbal Skills

Vocabulary: Help students understand the usage of words in different contexts.

Grammar (Medium Level): Train Students to comprehend the nuances of Grammar and empower them to spot errors in sentences and correct them.

Reading Comprehension (Basics): Introduce students to smart reading techniques and help them understand different tones in comprehension passages.

Reasoning: Enable students to connect words, phrases and sentences logically.

Oral Communication Skills: Aid students in using the gift of the gab to interpret images, do a video synthesis, try a song interpretation or elaborate on a literary quote.

References:

1. Adair. J., (1.986), "Effective Team Building: How to make a winning team", London, U.K: Pan Books.
2. Gulati. S., (2006) "Corporate Soft Skills", New Delhi, India: Rupa & Co.
3. The Hard Truth about Soft Skills, by Amazone Publication.
4. Verbal Skills Activity Book, CIR, AVVP
5. Nova's GRE Prep Course, Jeff Kolby, Scott Thornburg & Kathleen Pierce
6. The BBC and British Council online resources
7. Owl Purdue University online teaching resources
8. www.thegrammarbook.com online teaching resources
9. www.englishpage.com online teaching resources and other useful websites
10. Student Workbook: Quantitative Aptitude & Reasoning, Corporate & Industry Relations, Amrita Vishwa Vidyapeetham.
11. Quantitative Aptitude for All Competitive Examinations, Abhijit Guha.
12. How to Prepare for Quantitative Aptitude for the CAT, Arun Sharma.
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16. A Modern Approach to Logical Reasoning, R S Aggarwal.
17. A Modern Approach to Verbal & Non-Verbal Reasoning, R S Aggarwal.

Evaluation Pattern

Assessment	Internal	External
Continuous Assessment (CA)* – Soft Skills	30	-
Continuous Assessment (CA)* – Aptitude	10	25

Continuous Assessment (CA)* – Verbal	10	25
Total	50	50

*CA - Can be **presentations, speaking activities and tests**

23LSK301	**Life Skills III**	**L-T-P-C: 1-0-2-2**

Pre-requisite: Team Spirit, self-confidence and required knowledge, basic English language skills, knowledge of high school level mathematics.

Course Objective: To help students understand the nuances of leadership, know the importance of working in teams, face challenging situations, crack interviews, improve communication skills and problem-solving skills.

Course Outcomes

CO1: Soft Skills - To acquire the ability to work in teams, present themselves confidently and showcase their knowledge, skills, abilities, interests, practical exposure, strengths and achievements to potential recruiters through a resume, video resume, and personal interview.
CO2: Soft Skills - To have better ability to prepare for facing interviews, analyse interview questions, articulate correct responses and respond appropriately to convince the interviewer of one's right candidature through displaying etiquette, positive attitude and courteous communication.
CO3: Aptitude - To manage time while arriving at appropriate strategies to solve questions in geometry, statistics, probability and combinatorics.
CO4: Aptitude - To analyze, understand and apply suitable methods to solve questions on data analysis and data sufficiency.
CO5: Verbal - To use diction that is less verbose and more refined and to use prior knowledge of grammar to correct/improve sentences.
CO6: Verbal - To understand arguments, analyze arguments and use inductive/deductive reasoning to arrive at conclusions. To be able to generate ideas, structure them logically and express them in a style that is comprehensible to the audience/recipient.
Skills: Communication, teamwork, leadership, facing interviews and problem-solving.

CO-PO Mapping

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

Syllabus

Soft Skills

Team Work: Value of teamwork in organizations, Definition of a team. Why team? Effective team building. Parameters for a good team, roles, empowerment and need for transparent communication, Factors affecting team effectiveness, Personal characteristics of members and its influence on team. Project Management Skills, Collaboration skills.
Leadership: Initiating and managing change, Internal problem solving, Evaluation and co-ordination, Growth and productivity, Importance of Professional Networking.
Facing an interview: Importance of verbal & aptitude competencies, strong foundation in core competencies, industry orientation / knowledge about the organization, resume writing (including cover letter, digital profile and video resume), being professional. Importance of good communication skills, etiquette to be maintained during an interview, appropriate grooming and mannerism.

Aptitude

Geometry: 2D, 3D, Coordinate Geometry, and Heights & Distance.

Permutations & Combinations: Basics, Fundamental Counting Principle, Circular Arrangements, and Derangements.

Probability: Basics, Addition & Multiplication Theorems, Conditional Probability and Bayes' Theorem.

Statistics: Mean, Median, Mode, Range, Variance, Quartile Deviation and Standard Deviation.

Data Interpretation: Tables, Bar Diagrams, Line Graphs, Pie Charts, Caselets, Mixed Varieties, and other forms of data representation.

Data Sufficiency: Introduction, 5 Options Data Sufficiency and 4 Options Data Sufficiency.

Campus recruitment papers: Discussion of previous year question papers of all major recruiters of Amrita Vishwa Vidyapeetham.

Miscellaneous: Interview Puzzles, Calculation Techniques and Time Management Strategies.

Verbal Skills

Vocabulary: Create an awareness of using refined language through idioms and phrasal verbs.

Grammar (Advanced Level): Enable students to improve sentences through a clear understanding of the rules of grammar.

Reasoning Skills: Facilitate the student to tap his reasoning skills through Syllogisms, and critical reasoning arguments.

Reading Comprehension (Advanced): Enlighten students on the different strategies involved in tackling reading comprehension questions.

Public Speaking Skills: Empower students to overcome glossophobia and speak effectively and confidently before an audience.

Writing Skills: Practice closet tests that assess basic knowledge and skills in usage and mechanics of writing such as punctuation, basic grammar and usage, sentence structure and rhetorical skills such as writing strategy, organization, and style. Practice formal written communication through writing emails especially composing job application emails.

References:

1. Adair. J., (1.986), "Effective Team Building: How to make a winning team", London, U.K: Pan Books.

2. Gulati. S., (2006) "Corporate Soft Skills", New Delhi, India: Rupa & Co.
3. The Hard Truth about Soft Skills, by Amazone Publication.
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6. The BBC and British Council online resources
7. Owl Purdue University online teaching resources
8. www.thegrammarbook.com online teaching resources
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11. Quantitative Aptitude for All Competitive Examinations, Abhijit Guha.
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Evaluation Pattern

Assessment	Internal	External
Continuous Assessment (CA)* – Soft Skills	30	-
Continuous Assessment (CA)* – Aptitude	10	25
Continuous Assessment (CA)* – Verbal	10	25
Total	50	50

*CA - Can be **presentations, speaking activities and test**

OPEN ELECTIVES – PG

24OEL631 ADVANCED STATISTICAL ANALYSIS FOR RESEARCH 2 0 0 2

Objective: To familiarize students in application of statistical tool to enable them to easily perform complicated quantitative analysis.

Unit 1
Relevance of statistical analysis in research – scope of analysis in research - types of research – types of analysis in different areas.

Unit 2
Test of hypothesis - hypothesis testing procedure – significance level – steps for testing.

Unit 3
Chi-Square – t Test.

Unit 4
Tools for statistical analysis – familiarising the tool window – common buttons – available menu – entering and editing data.

Unit 5
Different types of analysis using tool.

REFERENCE BOOK:
C, R Kothari, Research methodology – Methods and techniques, New Age International Publishers

24OEL632 BASICS OF PC SOFTWARE 2 0 0 2

Objective: The main objective of this course is to familiarize the basic concepts of Microsoft Office 2007 applications which promote students to build their knowledge in business applications.

Unit 1
Word Processing Basic - An Introduction to Word Processing, Opening Word Processing package, menu bar, Using the help, Using he Icons below menu bar. Opening, saving and closing documents. Page setup, Page background, Printing of documents, Display/Hiding of Paragraph Marks and inter word Space. Moving around in a document - Scrolling the Document, Scrolling by line/paragraph, Fast scrolling and Moving Pages Text creation and manipulation - Paragraph and Tab setting, Text selection, cut, copy and paste, font and sizeselection, bold, italic and underline, Alignment of text: center, left, right and justify. Formatting the Text - Changing font, size and color, Paragraph indenting, bullets and numbering, Use of tab and Tab setting, changing case. Inserting – header and footer, page number, date & time, symbols, comments, auto texts, footnotes, citations, caption, index, pictures, files & objects, bookmark, hyperlink.

Unit 2

Handling multiple documents, Opening and closing of multiple documents, cut, copy and paste across the documents. Table Manipulation - Concept of table, rows columns and cells, draw table, changing cell width and height, alignment of text in cell, copying of cell, delete/insertion of row and columns, borders for table. Printing

– printing, print preview, print a selected page. Language Utilities – spelling & grammar- Mail merge options, password locking, View – Macros, document views

Unit 3

Elements of Electronics Spread Sheet, Application/usage of Electronic Spread Sheet, Opening of spreadsheet,and menu bar, Creation of cells and addressing of cells, cell inputting. Insert – tables, charts. Illustrations, links, texts. Page Layout – Themes, set up, scale, sheet, arrange. Practicing auto formatting and conditional formatting - Spelling and auto correct – Arranging windows – Freeze panes – Hiding windows. Providing Formulas - Using basic functions/ formalism a cell, Sum function, Average, Percentage, Other basic functions Data – connections, sort & filter, data tools, outline

Unit 4

Inserting slides – new slides, existing slides, duplicate slides, slides from Auto layout. Slide views – normal, slider sorter. Slide layouts, design templates. Deleting slides. Slide show – start with first slide, current slide, customize show. Inserting header & footer, Date and Time, Hyperlink, Format – Font, Bullet & Numbering. Custom animation, slide Transition.

Unit 5

Internet: Introduction to networks and internet, history, working of Internet, Modes of connecting to internet, ISPs, Internet address, standard address, domain name, Modems.

World Wide Web-Introduction, Miscellaneous Web Browsers details, searching the w w w - Directories search engines and meta search engines, search fundamentals, search engines, working of the search engines, Telnet and FTP.

TEXTBOOK:

Alexis Leon & Mathews Leon: Fundamentals of Information Technology, Vikas Publishing

REFERENCE BOOKS:

1. Microsoft Office 2000 Complete, BPB publications

2. Dennis P.Curtin, Kim Foley, Kunal Sen, Cathleen Morin: Information Technology - The Breaking Wave, TATA McGraw-Hill Edition

24OEL633 COMPUTER HARDWARE AND NETWORKING 1 0 1 2

Objectives: The course aims to give a general understanding of how a computer works. Students will be able to understand the basics of hardware and Networking technologies.

Unit 1

Hardware Basics - Basic Terms, Concepts, and Functions of System Modules, Front and rear panel

view of system – Motherboards: Components and Architecture. Popular CPU Chips and their Characteristics, Processor Architecture - Processor specifications - installing and uninstalling processor - CPU Overheating issues – common problems and solutions

Unit 2

Memory and Storage: Memory features – Types of memory – working - Installing and uninstalling memory modules –maintenance and troubleshooting – common problems and solutions. Storage devices – Hard diskdetails – Working and parts of hard disks – Installing hard disks – maintenance and troubleshooting.

Unit 3

Power supply – SMPS – features – types – installing SMPS – Specification for SMPS. Maintenance and Troubleshooting: Preventive Maintenance and Safety Procedures - Managing Replaceable Components.

Unit 4

Introducing Computer Networks: Overview - Types - Topology - Networks Defined by Resource Location - Client-Server Networks - Peer-to-Peer Networks - Dissecting the OSI Model - The TCP/IP Stack Layers of the TCP/IP Stack - Common Application Protocols in the TCP/IP Stack.

Unit 5

Networking Devices – Repeater, Hub, Switch, Router – Basics of Types of cabling – Crimping - Setting up aLAN.

TEXT BOOKS / REFERENCE BOOKS

1. *James K L, "Computer Hardware: Installation, Interfacing Troubleshooting and maintenance", PHI Learning Press (Eastern Economy Edition, 2013)*
2. *Mark Dye, Rick McDonald, Antoon Rufi, "Network Fundamentals: CCNA Exploration CompanionGuide", Cisco Networking Academy, 2008*
3. *Kaveh Pahlavan, Prashant Krishnamurthy," Networking Fundamentals: Wide, Local and Personal AreaCommunications ", Paperback, 2014*

24OEL634 CONSUMER PROTECTION ACT 2 0 0 2

Objective: To know about consumer rights and to understand the grievances redressal forums established under the Consumer Protection Act,1986.

Unit 1

Consumerism in India (Historical Background), Consumers: the concept, definition and scope. Object ofConsumer Protection Act, 1986.

Unit 2

Unfair Trade Practice, Restriction Trade Practice, Defect in goods, Deficiency in service: Medical, Lawyering, Electricity, Housing, Postal services etc.

Unit 3 Consumer rights and its protection; consumer protection councils, powers and functions.

Unit 4 Judicial Enforcement of Consumer Rights: Consumer Forum under C.P.Act - Jurisdiction, Powers and functions, Exceptions of order, Judicial Review, PIL, Class action, Remedies, Appeal, Administrative Remedies,C.P.Courts.

Unit 5 Appeals and orders: enforcement of orders of the consumer forum, Appeals against orders, Administrative control; Dismissal of frivolous and vexatious complaints, Penalties.

REFERENCE TEXTS:

1. Saraf D.N., Law of Consumer Protection in India, 1995

2. R.K.Bangia, Consumer Protection Act

3. P.K.Majumdar, The Law of Consumer Protection in India, 1998 Orient Publishing Co. Delhi

24OEL635 CORPORATE COMMUNICATION 2 0 0 2

Unit 1

Structure and characteristics of an organization; Factors influencing communication - Flow of communication in an organization - Bottom step, top down vertical and horizontal barriers tocommunication; Organization of a PR department and counselling firms.

Unit 2

Role of PR in an organization; PR processes - image building - PR and various publics - internal & external; PRand crisis management- national community, labour unrest, and accidents.

Unit 3

PR tools - House journals - kinds and production of house journals; Open house; New media; Gossip, rumourmongering and criticism.

Unit 4

Media Relations - press conference, press releases, press visit, interviews, preparations and distributions ofpublicity materials to media.

Unit 5

PR for Govt. PR for Non Govt. organizations, PR for armed forces, PR for entertainment and sports, PR fortourism, PR for philanthropic organizations, PR for celebrities. Event management, Ethics in PR.

BOOKS RECOMMENDED:

Balan K.R.: Lectures on applied Public Relations.

Dennis L. Wilcox, Philip H. Ault & Warren K. Agee: Public Relations strategies & tactics. Mehta D.S.: Handbook of Public Relations in India

Scott M.Cutlip, Allen H. Centre & Glen M. Broom: Effective Public Relations.

Philip Lesley: Lesley's Public Relations Handbook

Kaul J.M.: Public Relations Handbook.

Frank Jefkins: Planned Public Relations

Sam Black: The role of Public Relations in Management.

24OEL636 DESIGN STUDIES 2 0 0 2

Objective: To introduce the students to the field of visual design.

Unit 1
Drawing and illustration.

Unit 2
Design basics.

Unit 3
Principles of composition.

Unit 4
Introduction to type design.

Unit 5
Usage of images, colour in terms of visual design.

REFERENCES:

1. Thinking with Type by Ellen Lupton

2. How to be a Graphic Designer Without Losing Your Soul by Adrian Shaughnessy

24OEL637 DISASTER MANAGEMENT 2 0 0 2

Objectives: To appreciate the fundamentals of disaster management and to introduce the fundamentals procedure and working during the contingency.

Unit 1 Introduction & Dimensions of Natural & Anthropogenic Disasters, Principles/ Components of DisasterManagement, Organizational Structure for Disaster Management,

Unit 2 Disaster Management Schemes/ standard operating procedures, Natural Disasters and Mitigation Efforts, Flood Control, Drought Management, Cyclones, Avalanches, Mangroves, Land Use Planning, Inter- Linking of Rivers, Role of Union/ States, Role of Armed Forces/ Other Agencies In Disasters, Important Statutes/ Legal Provisions, Improvised Explosive Device/ Bomb Threat Planning, Nuclear, biological andchemical threat And Safety Measures, Forest Fires, Oil Fires, Crisis In Power Sector, Accidents In Coal Mines, Terrorism And Emergency Management.

Operations Management (OM), Risk Assessment and Disaster Response, Quantification Techniques,

NGO Management, SWOT Analysis based on Design & Formulation Strategies,

Unit 3 Insurance & Risk Management, Role of Financial Institutions in Mitigation Effort, Group Dynamics, Concept of Team Building, Motivation Theories and Applications, School Awareness and Safety Programmes, Psychological and Social Dimensions in Disasters, Trauma and Stress, Emotional Intelligence, Electronic Warning Systems, Recent Trends in Disaster Information Provider, Geo

Informatics in Disaster Studies, Cyber Terrorism, Remote Sensing & GIS Technology, Laser Scanning Applications in Disaster Management, Statistical Seismology, Quick Reconstruction Technologies,

Unit 4 Role of Media in Disasters, Management of Epidemics, Bio-Terrorism, Forecasting/ Management of Casualties.

Unit 5 Case Studies - Natural Disaster and Man-made Disasters.

REFERENCES:

1) Disaster Management - Harsh K Guptha

2) Disaster Management - Damon.P

24OEL638 ESSENTIALS OF CULTURAL STUDIES 2 0 0 2

Uniqueness of Indian culture.
Real Indian History.
Heritage – spiritual and cultural heritage.
Glory of ancient India – inventions and discoveries in all fields.Importance of festivals.

REFERENCE TEXTS:

1. Swami Harshananda – Hindu Culture

2. Amma – Eternal Truth

24OEL639 FOUNDATIONS OF MATHEMATICS 2 0 0 2

Objectives: To develop an understanding of problem solving methods, to understand the basic concepts of mathematics and to apply the results to real life business problems

Unit 1
Matrices: Type of matrices, addition, subtraction, multiplication of matrices, transpose, determinant of a matrix, adjoint and inverse of a matrix.

Unit 2
System of equations - Solution of equations in one(linear, quadratic), two and three variables, Solution of a system of linear equation having unique solution and involving not more than three variables by matrix method, Cramer's rule.

Unit 3
Financial mathematics: Simple interest and compound interest.Unit 4
Simple differentiation: functions, simple differentiation of algebraic functions, first and second orderderivatives, maxima and minima.

Unit 5
Elementary integral calculus: Integration of simple algebraic functions.

REFERENCES:

1. P.R Vittal - Business mathematics and statistics, Margham Publications, Chennai.

2. Dr. Amarnath Dikshit, Dr. Jinendra Kumar Jain - Business mathematics, Himalaya publishing House.

3. V.K Kapoor - Introductory Business mathematics, Sultan chand & Sons, New Delhi.

24OEL640 FOUNDATIONS OF QUANTUM MECHANICS 2 0 0 2

Unit 1

Historical Perspective of Quantum Physics: Failure of classical mechanics - Planck-Einstein, Bohr-de Broglie-

Heisenberg's Uncertainty.

Unit 2

Empirical confirmations of Wave Particle Duality. Schrödinger Equation - Particle in a box-

Tunneleffect.

Unit 3

Paradoxes in QM - de Broglie paradox - Schrödinger's cat, Mach-Zhender type interferometers - EPR paradox

- Bell-type Inequalities.

Unit 4

Various interpretations - Statistical, Copenhagen, Bohm's formulation, Transactional, Wheeler's Participatory

Universe, Many World, Decoherence, consciousness interpretation.

Unit 5

Uncertainty-Nonlocality, Holistic universe, Violations of causality-Retro influence-Philosophy of Advaitha(non-Duality).

TEXT AND REFERENCES:

1. Quantum Enigma: Physics Encounters Consciousness by Bruce Rosenblum and Fred Kuttner (Aug 1, 2011)

2. The New Physics and Cosmology Zanjoc, Oxford 2004

24OEL659 GLIMPSES OF LIFE THROUGH LITERATURE 2 0 0 2

Unit 1

1 Introduction – What literature is – Language and literature – Indian literature – Values through literature –

Literature and culture – Enjoying literature

2 Father Giligan – WB Yeats

Unit 2

3 The West Wind – PB Shelley

4 Chicago Address – Swami Vivekananda

Unit 3

5 On Saying Please – AG Gardiner

6 My Lost Dollar – Stephen Leacock

7 The Importance of Being Earnest – Oscar Wilde (extracts)

Unit 4

8 The Refugee – AK Abbas

9 The Mirrored Hall – Swami Chinmayananda

Unit 5

10 The Windhover – GM Hopkins

24OEL660 INFORMATION TECHNOLOGY IN BANKING 2 0 0 2

Objective: To provide an understanding on the technology enabled banking services and their applications.

Unit 1

Bank and Banking: Meaning and definition, development of banking in India, types banks, banking systems, types of banking systems, commercial banks, functions, nationalization of commercial banks in India.

Unit 2

Central Banking, functions, Reserve Bank of India, State Bank of India.

Unit 3

Banker and Customer, opening an account, Pass Book and Pay–in Slip, Cheques, types ofcheques, crossing of cheques.

Unit 4

Role of information technology in banking services, Core Banking, Automated Teller Machine (ATM),Electronic Clearing Service (ECS), NEFT and RTGS, Mobile Banking.

Unit 5

Debit Card and Credit Card, banking and E-Commerce, Point of Sales (PoS), Online bill payment and ticketreservation – future of electronic banking.

REFERENCE BOOKS:

1. Sundaram and Varshney – Banking Law, Theory and Practice, Sultan Chand

2. B. Santhanam – Banking and Financial Systems, Margham Publications

3. S.N. Maheswari – Banking Law, Theory and Practice, Kalyani Publications

4. Parameswaran – Indian Banking, S.Chand and Co

24OEL643 KNOWLEDGE MANAGEMENT 2 0 0 2

Objective: To enable students to understand the basics of Knowledge Management and its applications in organizations

Unit 1

Knowledge management concepts – Introduction - Definitions of Knowledge – Data-information and knowledge - basic thoughts on knowledge - difference between wisdom and knowledge - information Management and knowledge Management - hierarchy model - knowledge types – explicitness – reach - abstraction level – propositionality – Earl's schools of knowledge management.

Unit 2

Knowledge management and process - Becerra-Fernandez and Stevenson knowledge process - Nonaka's Knowledge Spiral – dynamics of knowledge creation – knowledge management systems – knowledge management sub – processes – knowledge discovery – knowledge capture – knowledge sharing –knowledgeapplication.

Unit 3

Organizational knowledge – Need – benefits - components and functions - Knowledge management in virtual organizations - knowledge management in professions - a study of IT and ITES business - knowledge management system requirements - Organizational knowledge measurement techniques - organizational implementation barriers.

Unit 4

Designing Enterprise Knowledge Management System architecture – Multi-layer architecture for Knowledge Management Systems - knowledge management in decentralized and heterogeneous corporations - Web based knowledge management support for document collections.

Unit 5

Recent Tools for KM - Intelligent support systems - intelligent systems and artificial intelligence - comparing artificial and neural intelligence - conventional vs. Artificial intelligence - Emerging technology - virtual reality - Intellectual capital.

TEXTBOOKS AND REFERENCES:

1. Knowledge Management – Sudhir Warier, Vikas Publications.

2. Knowledge Management Systems – Stuart Barnes, Thomson Learning.

3. Key issues in the New Knowledge Management – J.M. Firestone, M.W. Mcelroy.

4. Developing Expert System for Business – Chandler/Liang.

5. Knowledge Management – Pankaj Sharma, APH Pub

24OEL644 MARKETING RESEARCH 2 0 0 2

Objective: To provide a basic knowledge on research methodology and market research.

Unit 1

Definition of Marketing Research, Objective of Marketing Research, Application of

MarketingResearch, Limitation of Marketing Research, Marketing Research Process.

Unit 2
Research Design: Various Method of Research Design, Important Experimental Research Designs.

Primary and Secondary Data: Methods of Collecting Primary Data, Advantages & Disadvantages of Primary Data & Secondary Data, Essentials Characteristics for Selecting Secondary Data. Basic Methods of Collecting Data: Questionnaire Method/ Observation Method - Advantages & Disadvantages, Methods of Observation, Precautions in Preparation of Questionnaire & Collection of Data.

Unit 3
Measurement and Scaling: Types of Scales, Difficulty of Measurement, Sources of Error, Criteria for a Good Scale, Development of Marketing Measures.

Sampling: What is Sampling, Objective of Sampling, Steps in Sample Design, Various Techniques of Sampling, Advantages & Disadvantages of Different Techniques of Sampling, Difference between Probability and Non- probability Sampling, Problem Associated with Sampling, Determining Sample Size.

Unit 4
Data Processing, Analysis and Estimation

Unit 5
Report Preparation: Types and Layout of Research Report; Precautions in Preparing the Research Report, Bibliography and Annexure in Report, Drawing Conclusions, Giving Suggestions and Recommendation to the Concerned Persons.

REFERENCE TEXTS:

1. Nargundkar Marketing Research, Tata McGraw Hill, 2nd Ed.

2. Luck and Rubin Marketing Research, Prentice Hall of India, 7th Ed.

3. Tull & Hawkins Marketing Research: Measurement & Method, Prentice Hall of India, 6th Ed.

4. Beri Marketing Research, Tata McGraw Hill, 4th Ed.

24OEL645 MEDIA FOR SOCIAL CHANGE 2 0 0 2

Unit 1 Health Communication
Introduction to theories in Health Communication. Awareness on Health Issues – Epidemic Diseases, knowledge about vaccination for various diseases - Health campaign will be organized with the help of Medical Practitioner.

Unit 2 Radio for Social Change
Awareness on Edaphic Issues - Soil Pollution, Water Pollution and other forms of pollution. Anti–Pollutioncampaign will be organized with the help of Environmental Scientist or Journalist.

Unit 3 Social Media Activism

Awareness on Blood Donation – How a tiny red drop makes someone's life Green. Awareness campaign will

be organized based on Eye Donation.

Unit 4 Development Communication and Social Learning

Locating the remote village where basic amenities like Water, Toilet facilities are not available - A campaign with the involvement of government officials and social scientists.

Unit 5 Participatory Communication for Social Change

Organic Farming - Awareness of Organic Farming. Benefits of organic farming in the materialistic world. A campaign cum workshop will be conducted by inviting experts from Agricultural Husbandry.

REFERENCES

1. *Tillman, C. (2006). Principles of occupational health and hygiene: an introduction. Allen & Unwin.*
2. *Thayer, Lee, (2014) Mental Hygiene: Communication and the Health of the Mind.*
3. *Harrison, R. M. (2001). Pollution: causes, effects and control. Royal Society of Chemistry. Wilhelm, J. (2016). Environment and Pollution in Colonial India: Sewerage Technologies Along the Sacred Ganges. Routledge.*
4. *Charbonneau, J., & Smith, A. (Eds.). (2015). Giving Blood: The Institutional Making of Altruism. Routledge.*
5. *Agarwal, Arun K (2007) Standard Operating Procedures(sop) For Hospitals In India. New Delhi:*
6. *Atlantic Publishers*
7. *Hall-Matthews, D. N. J. (2005). Peasants, Famine and the State in Colonial Western India.*
8. *Basingstoke: Palgrave Macmillan.*
9. *Thottathil, S. E. (2014). India's Organic Farming Revolution: What it Means for Our Global FoodSystem. University of Iowa Press.*

24OEL646 MEDIA MANAGEMENT 2 0 0 2

Unit 1

Management concept – Principles of Management - Factors influencing Management decision in media – Structure and characteristics of media organizations – Newspapers and Magazines, Radio, Television, Cinema - Ownership in Media Industries – Merits and de-merits.

Unit 2

Economics of newspaper – Advertising vs circulation – Management problems of small, medium, large newspapers: gathering, processing, printing, circulation, distribution, advertising, professionalism, tradeunionism, News room diversity.

Unit 3

Economics and Administrative concerns of government owned electronic media-market driven media:private channels – Social commitment vs Profit making.

Unit 4

Economics of film Industry – creativity, production, marketing distribution, exhibition, ownership vs

piracy.

Unit 5

News agencies and syndicates: Ownership and organization structures – committees to study the problemsof various media in India.

BOOKS RECOMMENDED:

1. *Aggarwal S.K : Press at the crossroads in India.*
2. *William and Rucker: Newspaper Organization and Management*
3. *Sarkar R.C: The press in India*
4. *Noorani A.G: Freedom of Press in India*
5. *Frank Thayer: Newspaper Management*
6. *Gulab Kothari: Newspaper Management in India*
7. *Reports of the enquiry committees appointed by the Ministry of Information and Broadcasting.*

24OEL647 OBJECT-ORIENTED PROGRAMMING 2 0 0 2

Unit 1

Introduction to OOPS: Object Oriented Programming features, Applications, History, Difference from structured Programming, Object Oriented Programming Languages, Program execution.

Unit 2

Object Oriented Concepts: Abstraction, Encapsulation, Polymorphism, Inheritance, Classes and Objects, Programming Basics - Data types, Conditional Statements, Loops, arrays, Functions, Structures.

Unit 3

Implementing Class, Object Data Types, User Defined Data Types, Defining a Class, e Access specifiers, The Scope Resolution Operator, Using Class Objects Like Built-in Types, Scope, Constructors, Member Initialization, Constructor Overloading, Destructors.

Unit 4

Inheritance: Introduction, The protected Access Level, Assignments Between Base and Derived Objects, Types of Inheritance, Compile-Time vs. Run-Time Binding, virtual Functions, Polymorphism, Abstract Base Classes.

Unit 5

The iostream Library, Predefined Streams, Stream States, Formatted I/O, Disk Files, Reading and Writing Objects.

TEXTBOOKS

1. *E Balaguruswamy "Object Oriented Programming Using C++" 6th Edition, TMH Publications*
2. *Lalit Kishore Arora , Dr. Vikesh Kumar, " Object Oriented Programming Using C++ ",S.K. Kataria & Sons;*

   2011 edition (2011)

24OEL648 PAINTING AND SCULPTURE 1 0 1 2

Objective: To make students develop critical thinking skill as well as make them creative in their field of painting and sculpture.

Unit 1
Pencil drawing, life study.

Unit 2
Basics of water colour painting, Clay modelling.

Unit 3
Anatomy and figure study, Basics of oil and acrylic painting.

Unit 4
Basics of Figure modeling.

Unit 5
Moulding and casting.

REFERENCE BOOKS

1. Indian Sculpture and Painting – by E.B. Havell (Author)
2. Modern Painting And Sculpture: 1880 To Present From The Museum Of Modern Art – by JohnElderfield (Editor)

24OEL649 PERSONAL FINANCE 2 0 0 2

Objective: To analyse the process of making personal financial decisions, develop personal financial goals and identity the strategies for their achievement.

Unit 1
Basics of Personal Financial Planning, Time Value of Money, Planning tax strategies.

Unit 2
Introduction to Consumer Credit, sources of credit, Consumer Purchasing, strategies for housing decisions.

Unit 3

Insurance: types, selecting the right insurance policy, property and motor vehicle insurance, healthinsurance policies, Retirement Planning, NPS.

Unit 4
Investing fundamentals, investing in shares, bonds and mutual funds, investment in gold and realestate.

Unit 5
Investing in Schemes of Government: National Savings Certificates, KVP, Post Office RecurringDeposits and term deposits, PPF.

REFERENCE TEXTS:

1. Jeff Madura – Personal Finance, Pearson Education

2. Manish Chauhan – 16 Personal Finance Principles every Investor should know, Network18 Publishers

3. Jack R Kapoor, Les R Dlabey – Personal Finance, McGraw Hill

24OEL650 PRINCIPLES OF ADVERTISING 2 0 0 2

Objective: The objective of this paper is to help student to make basic understanding on advertising, providing understanding on the processes behind successful advertising. The students are introduced to the processes, tools and techniques used in developing advertising concepts with the study areas including creative thinking and visualizing.

Unit 1 Introduction
History of advertising, Advertising-meaning and definition, Advertising as a tool of communication, Features of advertising.

Unit 2 Types of Media – Advantages & Disadvantages
Types of advertising, Types of media in advertising – Features – advantages – disadvantages – Print, Television, Radio, Internet, OOH.

Unit 3 Structure of an Advertising Agency
Structure of advertising agency – Small, Medium, National, In-house.

Unit 4 Other Promotion
Sales Promotion, Direct Marketing, Public Relations, Publicity and Corporate Advertising, UnconventionalPromotional Media.

Unit 5 Case Studies

REFERENCE BOOKS:

Advertising, Frank Jefkins Revised by Daniel Yadin

Kleppner's Advertising Procedure

24OEL651 PRINCIPLES OF PACKAGING 2 0 0 2

Objective: To analyse the process of making personal financial decisions, develop personal financial goals and identity the strategies for their achievement.

Unit 1
Packaging: Meaning and importance, functions, marketing considerations of packaging.

Unit 2
Design of package, materials used for packaging, selection criteria of packaging materials, packing techniques.

Unit 3
Packaging systems, future of packaging.

Unit 4
Provisions of the Legal Metrology (Packaged Commodities) Rules 2011.

Unit 5
Provisions of Food Safety Standards (Packaging and Labelling) Regulations, 2011.

REFERENCE TEXTS:

1. Gordon Robertson – Food Packaging: Principles and Practice, CRC Press

2. Frank Paine – A Handbook of Food Packaging, Springer

24OEL652 SCRIPTING FOR RURAL BROADCASTING 1 0 1 2

Unit 1
Introduction to rural broadcasting. Rural life and issues. Cultural ecology - Anthropological approaches - traditional social activities-translocal ruralistic features.
Practical: Visit any rural area for making detail analysis on the topics during weekends.

Unit 2
Rural communities. Analysis of social and political life in a rural community. Caste / class dynamics and regional influences.

Unit 3
Scope and Impact of broadcast journalism in rural development. Two day workshop by an external expertfrom the broadcast industry on the rudiments of script writing focusing on rural aspects/ communities.

Unit 4
Practice on Scripting. Focus on covering special issues concerning rural women, youth, farmers, self-helpgroups cottage industries etc.

Unit 5
Developing the final script for rural broadcasting that will have practical application in the

field. Finalevaluation by the external expert.

REFERENCES

1. *Eschenbach, J. (1977). The role of broadcasting in rural communication.*
2. *Friedrich-Ebert-Stiftung. George, A. M. (2004). India untouched: The forgotten face of rural poverty. East West Books.*
3. *Kumar, K. (2003). Mixed signals: Radio broadcasting policy in India. Economic and political weekly, 2173-2182.*
4. *Maddison, J. (1971). Radio and television in literacy. Unesco.*
5. *Manyozo, L. (2011). People's radio: communicating change across Africa. Southbound Penang*
6. *Neurath, P. M. (1962). Radio farm forum as a tool of change in Indian villages. Economic Development andCultural Change, 10(3), 275-283.*
7. *Onabajo, F. (2003). 37 Message Design & the Appropriateness of Language in Rural Broadcasting. FourDecades in the Study of Languages & Linguistics in Nigeria: O'Hare, K. (1992). Scripts: Writing for Radio and Television. Canadian Journal of Communication, 17(4).*
8. *Sharma, A., & Kashyap, S. K. (2013). Information need assessment for empowering rural women throughcommunity radio programmes: A study in Tarai region of Uttarakhand. Journal of*
9. *Community Mobilization and Sustainable Development, 8(2), 169-173.*

24OEL653 SOCIAL MEDIA WEBSITE AWARENESS 1 0 1 2

Objectives; To understand the history, theory, technology and uses of social media; to create, collaborate, and share messages with audiences of all sizes; to know and explore the possibilities and limitations of social media. Hands on experience with several forms of social media technology; to understand and use social media productively and to evaluating new tools and platforms.

Unit 1

Introduction to Social media; Definition - Social Media and Digital transformation; Social Networking and online communities; Social support and service; Wikipedia, Facebook, Instagram, Tagging, LinkedIn; Social mobile applications; Security settings in Facebook, Whatsapp.

Unit 2

Blogging – History; Creating blog, effect of blogging, micro blogging; Protocol, Platform, Content strategies.

Unit 3

Tweeting - Introduction, History, Protocol; Twitter; Twitter apps; Managing Twitter; #hashtag# creation andfollowing; Security settings in Twitter.

Unit 4

Social media sharing – History, Protocol; YouTube, Flickr, Slide share, Social news; News apps – Newshuntand others; Bookmarking - History, Digg, Reddit, Delicious.

Unit 5

Social theory in the information age; Social Network for professional, business, Digital Marketing;

Usingsocial networking sites for research, Security aspects of social networking.

REFERENCES:

1. *Social Networking - Digital and Information Literacy Series by Peter K. Ryan, The Rosen Publishing Group,*

   2011 ISBN 1448823463, 9781448823468

2. *The Social Media Marketing Book Dan Zarrella "O'Reilly Media, Inc.", 13-Nov-2009*

24OEL654 THEATRE STUDIES 1 0 1 2

Objective: To provide students with a firm grounding in the discipline of Theatre and Performance Studies.

Unit 1
Breathing exercises, warming up exercises.

Unit 2
Voice modulation, Monologue practice.

Unit 3
Facial expressions, emoting a character.

Unit 4
Stage direction, Makeup and costumes.

Unit 5
Choreography, Producing a play.

REFERENCES:

1. *Theatre as Sign System: A Semiotics of Text and Performance by Elaine Aston, George Savona*
2. *Theatre Semiotics: Text and Staging in Modern Theatre by Fernando de Toro*
3. *Acting For Real: Drama Therapy Process, Technique, and Performance by Renee Emunah*

24OEL655 WRITING FOR TECHNICAL PURPOSES 2 0 0 2

Overview: The course aims at developing skills that will enable students to produce clear and effective scientific and technical documents as required in their work-life. Though the focus of the course is on writing, oral communication of scientific and technical information forms an important part of the course.

Objectives: To familiarize the students with the requirements of effective technical writing; to enable students to independently work on their publication and presentation of papers; developing skills required for presentation of reports, papers and proposals

Unit 1
What is Technical Writing? - Purpose and characteristics of technical writing and need for developing technical writing skill. Use of Technical terms, Defining terms, Style and tone.

Unit 2
Use of resources, documentation style and citation; Standard operation procedures, Instruction Manuals and Handbooks.

Unit 3

Oral presentations, Analysis of published papers – format, content and style.

Unit 4
Drafting a research paper for publication; Grammar check and editing; proof reading.

Unit 5
Submission of term paper.

REFERENCE BOOKS:

1. Mcmurrey David, Technical Writing,

2. Manser Martin H. Guide to Style: an essential guide to the basics of writing style, Viva books

24OEL656 YOGA AND PERSONAL DEVELOPMENT 1 0 1 2

Objective: To give an understanding on the concept and advantages of yoga and simple yoga practices.

Unit 1
Yoga and Modern Life – Introduction - understanding Yoga – definition - four streams of yoga - Why yoga?

Unit 2
Breath – The Bridge – Introduction - Breathing Practices – Standing - Sitting – Supine.

Unit 3
Loosen Yourself – Introduction – Jogging – Bends - Twisting – Pavanamuktasana Kriya.

Unit 4
Asanas – Suryanamaskar - Standing Posture - Sitting postures - Prone Postures - Supine – Topsy Turvy -Relaxation techniques.

Unit 5
Pranayama, Meditation.

REFERENCE TEXTS:

1. N.S. Ravishankar – Yoga for Health, Pustak Mahal

2. BKS Iyengar – Yoga: The Path to Holistic Health, DK Publishers

24OEL657 FUNDAMENALS OF LEGAL AWARENESS 2 0 0 2

Objective: This course is intended to give the student the power to make a difference in personal and professional life through sound legal knowledge and to be aware of rights and responsibilities towards societyand nation.

Unit 1
Law and classification: definition, meaning, functions, classification- public and private law, civil law andcriminal law, substantive and procedural law, municipal and international law, written and unwritten laws

Unit 2

Law of contracts: overview of Indian Contract Act, definition, meaning, essentials-offer and acceptance, invitation to offer, cross offers, intention to create legal obligation, lawful consideration, lawful object, competency of parties, free consent, agreement not to be void, illegal, immoral or opposed to public policy, agreement v. contract, breach and remedies for breach.

Unit 3

Law of torts: Definition, meaning, essentials, damages- injuria sine damnum and damnum sine injuria, generaldefences in torts, exceptions to tortious liability: vicarious liability- master servant relationship, Principal- agent relationship, Partner- partnership firm, Major torts: Nuisance, Negligence

Tress pass: Tresspass to a person- Battery, Assault, False Imprisonment, defamation- libel and slander, essentials, defences to defamation, liability in torts- strict liability, absolute liability, damages in torts- meaning, types of damages- nominal, compensatory, exemplary, aggravated, prospective, contemptuous

Unit 4

Criminal law: introduction of criminal law- subject matter, General introduction to the Indian Penal Code, Criminal Procedure code, Indian Evidence Act, mental element- stages of crime, guilty intention, General exceptions- Intoxication, Insanity, Mistake of Fact, Accident, Acts done under compulsion, public duty etc., Right of Private Defence, Major offences: Theft, Extortion, Robbery, Dacoity, Sedition, Abduction, Kidnapping, Unlawful Assembly, Dowry Death, Abetment, Murder, Culpable Homicide

Unit 5

Family law: subject matter and Introduction, Laws Involved, Marriage – validity and degree of prohibited relationship, Divorce Family Court, Grounds for divorce, orders- judicial separation, restitution of conjugal rights, maintenance, Section 125 Criminal Procedure code, Adoption- difference between guardianship and adoption, General outline of Hindu Adoption and Maintenance Act, Guardianship and Wards Act, Succession- Testamentary and Intestate- Testator, Executor, Administrator and Probate

11. Specific Regulations to be included, if any

i. The proposed 4-year BSc (Honours) course in Chemsitry will be consisting of 8 semesters.

ii. Students pursuing the 4-year BSc (Honours) course in Chemsitry should acquire a total of 105 credits [~ 58 % of the total credit] after the 8 semesters from the "Major discipline" courses [i.e. Chemsitry core courses], which is the discipline or subject of main focus and the degree will be awarded in that discipline.

iii. Students should mandatorily participate in a one-month summer internship program to secure 4 credits at any point during the 4 years.

iv. Studnets are allowed to take exit after 6^{th} semester [at the end of 3 years] with a "BSc in Chemistry" degree. Total credits to be earned at this stage is 144 of which 4 credits compulsorily to be earned from summer internship. These students also should have satisfied the credit requirements as given in table "Credit at a glance" in Section 9.

v. Students leaving at the end of 3^{rd} year should mandatorily complete a "Minor project" and submit his/her dissertation. This project has to be done under the supervision of any of the faculties within the department.

vi. A 4-year BSc (Honours) in Chemistry will be awarded to those who complete a 4-year degree programme with 181 credits and have satisfied the credit requirements as given in table "Credit at a glance" in Section 9. They should complete a "Minor project" under the guidance of a faculty member of the University. The Minor project should be related to the major discipline i.e. Chemistry. The students, who secure 181 credits including 3 credits from the Minor project, can be awarded BSc (Honours) in Chemistry without Research.

vii. Students, who manage to score > 7.5 CGPA after 6 semesters, only will be eligible to pursue BSc (Honours) with Research in Chemistry. They can choose a research stream in the 4^{th} year. They should do a "Major project" or dissertation under the guidance of a faculty member of the University or in any external academic institution/industry. The research project/dissertation will be related to the major discipline i.e. Chemistry. The students who secure 181 credits, including 15 credits from the "Major project" or dissertation, shall be awarded BSc (Honours) in Chemistry with Research.

viii. The students can opt for optional Minor courses other than their Major discipline area. Students need to secure an additional 18 credits from the assigned minor courses as mentioned in the section 10 Annexure I.

ix. An overall attendance of 75 % should be maintained in all the semester to be eligible to appear for the End semester examination.

12. Essential Resources **(Needed, Available, to be created & when)**

We are planning to conduct the 4-year BSc (Honours) and the Integrated MSc classes together. Hence, we do not require any new infrasture related to either classroom or laboratory.

13. Does the start of the Programme need the approval of any Statutory Body / Council?

The curriculum and syllabus have been presented to the Board of Studies as well as Leadership Coucil. Both the panels have approved the curriculum and the syllabus.

14. Details of other Universities / Institutions offering similar programmes

a) M G Uniersity, Kerala
b) Kerala University
c) Calicut University
d) Kannur University
e) Pondicherry University
f) Bangalore University
g) University of Calcutta
h) Delhi University
i) Jain University [Deemed to be]