COURSES OF STUDIES

FOR

5 yr. Int. M.Sc.

In

Applied Chemistry

(Up to 6th semester)

BIJU PATNAIK UNIVERSITY OF TECHNOLOGY, ODISHA

5-year Integrated M.Sc in Applied Chemistry Syllabus

1ST Semester				2nd Semester			
Theory		Contact Hours		Theory		Contact Hours	
Code	Subject	L-T-P	Credit	Code	Subject	L-T-P	Credit
FCYC101	Inorganic Chemistry-I	3-0-0	3	FCYC201	Inorganic Chemistry-II	3-0-0	3
FCYC102	Physical Chemistry-I	3-0-0	3	FCYC203	Organic Chemistry-I	3-0-0	3
FPYE106	Physics-I	3-0-0	3	FPYE206	Physics-II	3-0-0	3
FMCE107	Math –I	3-0-0	3	FMCE207	Math-II	3-0-0	3
FHMF109	Communicative English	2-0-0	2	FHMF209	Business Communication English	2-0-0	2
FBEF111	Fundamentals of computers & Programming in C	3-0-0	3	FBEF210	Data structure using C	3-0-0	3
		Total	17			Total	17
Practical/Sessional		Contact Hours		Practical/Sessional		Contact Hours	
Code	Subject	L-T-P	Credit	Code	Subject	L-T-P	Credit
FCYC151	Chemistry Lab-I	0-0-3	2	FCYC251	Chemistry Lab -II	0-0-3	2
FPYE156	Physics Lab-I	0-0-3	2	FPYE256	Physics Lab-II	0-0-3	2
FHMF159	Communicative English Lab	0-0-3	2	FHMF259	Business Communication English Lab	0-0-3	2
FBEF161	Programming in C lab	0-0-3	2	FBEF260	Data structure using C Lab	0-0-3	2
		Total	8			Total	8
		Total	25			Total	25

3rd Semester				4th Semester			
Theory		**Contact Hours**		**Theory**		**Contact Hours**	
Code	**Subject**	**L-T-P**	**Credit**	**Code**	**Subject**	**L-T-P**	**Credit**
FCYC301	Organic Chemistry-II	3-0-0	3	FCYC401	Inorganic Chemistry-III	3-0-0	3
FCYC302	Physical Chemistry-II	3-0-0	3	FCYC403	Organic Chemistry-III	3-0-0	3
FPYE306	Physics –III	3-0-0	3	FPYE406	Physics-IV	3-0-0	3
FMCE307	Math –III	3-0-0	3	FMCE407	Math-IV	3-0-0	3
FHMF309	Organizational Behaviour	3-0-0	3	FHMF409	Economics	3-0-0	3
FBEF311	OOPS using C++	3-0-0	3	FBEF411	RDBMS	3-0-0	3
		Total	**18**			**Total**	**18**
Practical/Sessional		**Contact Hours**		**Practical/Sessional**		**Contact Hours**	
Code	**Subject**	**L-T-P**	**Credit**	**Code**	**Subject**	**L-T-P**	**Credit**
FCYC351	Chemistry Lab -III	0-0-3	2	FCYC451	Chemistry Lab -IV	0-0-3	2
FPYE356	Physics Lab-III	0-0-3	2	FPYE456	Physics Lab-IV	0-0-3	2
FBEF361	OOPS using C++ Lab	0-0-3	2	FBEF461	RDBMS Lab	0-0-3	2
		Total	**6**			**Total**	**6**
		Total	**24**			**Total**	**24**

5th Semester				6th Semester			
Theory		**Contact Hours**		**Theory**		**Contact Hours**	
Code	Subject	L-T-P	Credit	Code	Subject	L-T-P	Credit
FCYC501	Physical Chemistry-III	4-0-0	4	FCYC601	Physical Chemistry-IV	4-0-0	4
FCYC502	Organic Chemistry-IV	4-0-0	4	FCYC602	Inorganic Chemistry-V	4-0-0	4
FCYC503	Inorganic Chemistry-IV	4-0-0	4	FCYC603	Quantum Theory	3-1-0	4
FCYE504	Instrumental Methods of Chemical Analysis-I	3-0-0	4	FCYF604	Environmental Chemistry	3-1-0	4
FCYE505	Symmetry and Group Theory	3-1-0	3	FCYF605	Solid State Chemistry	3-0-0	3
		Total	**19**			**Total**	**19**
Practical/Sessional		**Contact Hours**		**Practical/Sessional**		**Contact Hours**	
Code	Subject	L-T-P	Credit	Code	Subject	L-T-P	Credit
FCYC551	Physical Chemistry Lab-I	0-0-3	2	FCYC651	Physical Chemistry Lab-II	0-0-3	2
FCYC552	Organic Chemistry-Lab-I	0-0-3	2	FCYC652	Inorganic Chemistry Lab-II	0-0-3	2
FCYC553	Inorganic Chemistry Lab-I	0-0-3	2	FCYC653	Instrumental Methods of Chemical Analysis Lab	0-0-3	2
		Total	**6**			**Total**	**6**
		Total	**25**			**Total**	**25**

| FCYC101 | Inorganic Chemistry-I | 3-0-0 | 3 |

Module-I

Atomic structure: de-Broglie matter waves, Uncertainty principle, Schrodinger wave equation(excluding derivations), quantum numbers and its significance, Radial and angular wave functions, spherical harmonics, Radial and angular distribution curves, shapes of s, p, d orbitals, selection rules and electronic configuration of elements.   **[6hrs]**

Module-II

Periodic properties: Screening effect, effective nuclear charge, size of atoms and ions, ionization potential, electron affinity, electronegativity, variable valency and oxidation states, horizontal, vertical and diagonal relationship.   **[6hrs]**

Module-III

Chemical bonding- I: Ionic bond, polarizability, Fajan's rule , structure of ionic solids, radius ratio rules, close packing, classification of ionic structures(compounds of the type AX, AX_2,), lattice energy and Born- Haber cycle, solvation energy and solubility of ionic compounds, stoichiometric defects, non-stoichiometric defects.   **[12hrs]**

Module-IV

Chemical bonding- II: Lewis theory, dipole moment and its application, percentage ionic character from dipole moment and electronegativity, VBT, hybridization,VSEPR theory, MOT(homo and heteronuclear diatomic molecule), Resonance   **[6hrs]**

 Metallic bond(free electron and band theories) H-bond, Vander waals force.   **[3hrs]**

Essential readings:

1. J.D. Lee, Concise Inorganic Chemistry, 5th edition, Blackwell Publishing, 2008
2. Huheey, Keiter and Keiter, Inorganic chemistry Principle, structure and reactivity. 4Th edn
3. Inorganic Chemistry R.D.Madan, S.Chand Publication
4. Basic Inorganic Chemistry Cotton & Willikinson

FCYC102	Physical Chemistry-I	3-0-0	3

Module-I

Gaseous state: Postulates of Kinetic theory of gases, deviation from ideal behavior, vander walls equation of state. Critical phenomena: PV isotherm of real gases, continuity of states, the isotherms of van der walls equation, relationship between vander waals constant and critical constants, the law of corresponding states, reduced equation of state.

Molecular velocities and the relation between them, qualitative discussion on Maxwells distribution of molecular velocity, collision number, mean free path and collision diameter, liquefaction of gases(based on Joule-Thomson effect) **[7hrs]**

Module-II

Liquid state: Intermolecular forces, structure of liquids (qualitative description), liquid crystals: difference between liquid crystals, solids and liquids. Classification, structure of nematic and cholestric phases. Thermography and seven segment cell. **[4hrs]**

Module-III

Solid state: space lattice and unit cell. Law of crystallography, symmetry elements in crystals. X-ray diffraction in crystals. Derivation of Braggs eqn., Determination of crystal structure of NaCl, KCl and CsCl **[10hrs]**

Module-IV

Chemical Kinetics and catalysis: Rates of reactions, factors influencing rates of reaction- conc., temp, pressure, solvent, light, catalyst. Arrehenius eqn. concept of activation energy, collision theory of reaction rates, transition state theory, Order and molecularity, mathematical characteristics of simple chemical reactions-zero order, first order, second order, pseudo order, half and mean life.

Determination of the order of reaction (differential method, half life period method,method of isolation and integration)

Catalysis: characteristic of catalysed reactions, classification of catalysis

[12hrs]

Essential readings:

1. P.W. Atkins and Julio de Paula, Elements of Physical Chemistry, Oxofrd University Press, 1992
2. M. R. Wright, An Introduction to Chemical Kinetics, John Wiley & Sons, 2005.
3. J. Raja Ram, and J. C. Kuriacose,Kinetics and Mechanism of Chemical Transformations, MacMillan Indian Ltd., New Delhi, 1993.
4. G N Barrow, Physical Chemistry, TATA MCGRAW-HILL, 2007.
5. K. L. Kapoor, Text Book of Physical Chemistry, MACMILLAN, 2006
6. R. I. Masel, Chemical Kinetics & Catalysis, Wiley-Interscience; 1st Edition, 2001.
7. K. K. Rohatgi, S. Mukherjee, Fundamentals of Photochemistry, Wiley, New York, 3rd Edition

FPYE106	Physics-I	3-0-0	3

Module-I

Motion of a system of particles: centre of mass, velocity, acceleration, momentum, Equation of motion, Kinetic energy and angular momentum of centre of mass. Conservation of linear momentum and angular momentum for system of particles, moment of inertia, parallel axis theorem perpendicular axis theorem. Moment of inertia of cylinder and sphere. Rotational kinetic energy and power, g by compound pendulum (bar pendulum).Gravitational force, field potential energy and potential, gravitational potential and field at a point due to a thin spherical shell and a solid sphere.

(10)

Module-II

Central force motion, reduction of two body problems into an equivalent one body problem, general characteristics of central force motion. Derivation of Kepler's laws of planetary motion from gravitational force.

Module-III

Relation between elastic constants. Torsion of a cylinder, bending of beams, expression for bending moment, equation for bending, depression occurring at nth e free ends of a light, heavy cantilever. Viscosity of liquids, laminar flow through a narrow tube and poisseuille's formula surface tension-pressure difference across curved membrane.   (12)

Module-IV

Oscillation And Waves: Simple harmonic oscillator,damped harmonic oscillator,power loss,Q-factor,overdamped motion,critical damping,forced vibration,resonance,sharpness of resonance.Mathematical description of travelling waves,wave equation.Tansverse waves in a stretched string longitudinal waves in a gaseous medium,composition of simple harmonic waves.Lissajous figures.   (8)

Essential readings:

1. Classical Mechanics- H Goldstein (Narosa)
2. Classical Mechanics-Rana And Joag (TMH)
3. Introduction to Classical Mechanics- Takwale & Purnaik(TMH)
4. Mechanics- K R Simon (Addision Wesley)
5. Mechanics-D. S Mathur (S. Chand)
6. Properties of matter- Searle and Neaman (Arnold Publication)
7. Classical Mechanics- M. Das , P.K Jena (Sri krishna Publication)

Classical Mechanics- Kibble

FMCE107	Math –I	3-0-0	3

Module-I : (14 Hours)

Basic Concepts of Differential Equation: Origin and Classification of Differential equation, Solution of Differential Equation, Kinds of solution, Initial and Boundary value problem, Existence and uniqueness of solution, Formation of Differential equation. **First Order First Degree Equation:** Variable separable, Homogenous Equation, Exact Differential equation, Integrating Factors, Linear equations, Equation reducible to linear form.

Equations of First order but of Higher Degree : Equations solvable for p, Equation solvable for y, Equation solvable for x,

Module-II : (14 Hours)

Linear Equations with Constant coefficient : Linear differential equation of nth order, Homogenous Linear equation with constant coefficient, Non- Homogenous Linear equation with constant coefficient, Operators and its use to solve linear differential equations with constant coefficient, Method of Variation of Parameter, Linear Differential Equation with variable coefficient: Method of reduction of order, method based on the removal of the first derivatives.

Existence and Uniqueness of solution: Picard's method of successive Approximation, Existence and uniqueness Theorem.

Module-III : (12 Hours)

Series Solution and special function: Power series, Radius of convergence of power series, Ordinary point, singular point and regular singular point(only definition), Series solution about an ordinary point, Legendre equation and Legendre polynomial, Orthogonality, Power series method about singular point, Bessel 's equation and Bessel's function, Orthogonality in Bessel function. Boundary value problem for Ordinary Differential Equation; Sturm –Liouville Problems.

Text Books:

1.   A Course on Ordinary and Partial Differential Equation by J. Sinha Roy, S Padhy, Kalyani Publisher.
Chapters:1(1.1-1.4),2(2.1-2.7),3(3.1-3.4)4(4.1-4.6),6(6.1,-6.3),7(7.1,7.2,7.3(7.3.1),7.4(7.4.1)),10
           (10.1,10.2).

Reference Books:

1.   Ordinary Differential Equation by P C Biswal (Pub- PHI)

| FHMF109 | Communicative English | 2-0-0 | 2 |

Module-I

The elements of communication   **[6 hrs]**

1.1 the importance of communication through English at the present time

1.2 the process of communication and factors that influence communication : sender, receiver, channel, code, topic, message, context, feedback, 'noise', filters and barriers

1.3 the importance of audience and purpose

1.4 the information gap principle : given and new information ; information overload

1.5 verbal and non-verbal communication : body language

 1.6 comparing general communication and business communication

Module-II The sounds of English   **[14 hrs]**

2.1 vowels, diphthongs, consonants, consonant clusters

2.2 the International Phonetic Alphabet (IPA) ; phonemic transcription

 2.3 problem sounds

2.4 syllable division and word stress

2.5 sentence rhythm and weak forms

 2.6 contrastive stress in sentences to highlight different words

 2.7 intonation : falling, rising and falling-rising tunes

2.8 varieties of Spoken English : Standard Indian, American and British (Note : This unit should be taught in a simple, non-technical manner, avoiding technical terms as far as possible.)

Module-III

 Review of English grammar   **[10 hrs]**

3.1 stative and dynamic verbs

3.2 the auxiliary system ; finite and non-finite verbs

3.3 time, tense and aspect

 3.4 voice: active and passive

 3.5 modality

3.6 negation

3.7 Interrogation ; reported and tag questions

 3.8 conditionals

3.9 concord

3.10 Phrasal verbs (Note The teaching of grammar should be treated as a diagnostic and remedial activity and integrated with communication practice. The areas of grammar in which errors are common should receive special attention when selecting items for review. Teaching need not be confined to the topics listed above.))

 Essential readings:

1. An Introduction to Professional English and Soft Skills by B.K.Das et al., Cambridge University Press.

FBEF111	Programming in C & Fundamentals of computers	3-0-0	3

Module-I :(10 Hours)

Digital Logic Fundamentals: Logic Gates, Introduction to Multiplexer, De-multiplexer, Encoder, Decoder & Flip-Flops.

Introduction to Computer Fundamentals: Basic architecture of computer, Functional units, Operational concepts, Bus structures, Von Neumann Concept. Instruction code, Instruction set, Instruction sequencing, Instruction cycle, Instruction format, Addressing modes, Micro instruction, Data path, Hardwired controlled unit, Micro programmed controlled unit.

Generation of Programming languages, Compiler, Linker, Loader

Module-II :(10 Hours)

C language fundamentals: Character set, Key words, Identifiers, data types, Constants and variables, Statements, Expressions, Operators, Precedence and associativity of operators, Side effects, Type conversion, Managing input and output

Control structures: Decision making, branching and looping.

Arrays: one dimensional, multidimensional array and their applications, Declaration, storage and manipulation of arrays

Strings: String variable, String handling functions, Array of strings

Functions: Designing structured programs, Functions in C, Formal vs. actual arguments, Function category, Function prototype, Parameter passing, Recursive functions.

Storage classes: Auto, Extern, register and static variables

Module-II :(10 Hours)

Pointers: Pointer variable and its importance, pointer arithmetic and scale factor, Compatibility, Dereferencing, L-value and R-value, Pointers and arrays, Pointer and character strings, Pointers and functions, Array of pointers, pointers to pointers, Dynamic memory allocation

Structure and union: declaration and initialization of structures, Structure as function parameters, Structure pointers, Unions.

File Management: Defining and opening a file, Closing a file, Input/output Operations in files, Random Access to files, Error handling

Text Books:

1. William Stalling , " Computer Organization and Architecture "Pearson Education
Balagurusamy : "C Programming" Tata McGraw-Hill

Reference Books:

J. P. Hayes "Computer Architecture and Organization" McGraw Hill Education India.
H. Schildt – "C the complete Reference" McGraw-Hill
K.R. Venugopal, S.R. Prasad, " Mastering C, McGraw-Hill Education India

FCYC151	Chemistry Lab-I	0-0-3	2

Qualitative analysis of mixture of inorganic substances containing six ions (including anions like phosphate, fluoride and mixture of anions like carbonate, sulfite, sulfide, nitrate, chloride, bromide, phosphate, arsenate, nitrate, iodate and sulfate and cations of qualitative groups I, II, III, IV, V and VI)

Estimation of Ca^{2+} and Mg^{2+} by EDTA

Determination of pH of a buffer solution

Determination of viscosity of a lubricating oil.

To determine the viscosity of amyl alcohol in water at different concentrations and calculation of excess viscosity of these solutions.

Determination of flash and fire point of an oil by Pensky-Marten apparatus.

Determination of concentration of a coloured solution by a spectrophotometer.

To determine the percentage composition of a given binary mixture (acetone and ethylmethyl ketone) by surface tension method.

Essential Reading

1. R.C. Das and B. Behera , Experimental Physical Chemistry, , Tata McGraw Hill 2000
2. G. Svehla, Vogel's qualitative inorganic analysis, Harlow Longman, 2002.
3. A I Vogel, John Bassett, Vogel's textbook of quantitative inorganic analysis: including elementary instrumental analysis, Longman,2003
4. D. Alart, Practical Physical Chemistry, Longman, 1993.
5. A I Vogel , Qualitative Inorganic Analysis, Orient Longman – 1979.

FPYE156	Physics Lab-I	0-0-3	2

1.   Determination of accurate weight of a body using balance by Gauss method.

2.   Determination of specific heat of liquid by the method of cooling.

3.   Determination of   velocity of sound by resonance column method.

4.   Acceleration   due to gravity   by bar pendulum and study of the effect of Amplitude on timeperiod.

5.   Acceleration due to gravity   by Kater's pendulum.

6.   Specific heat of a conducting solid by method of mixture (using radiation Correction.)

7.   Verification of laws of vibration of string   using sonometer.

8.   Determination of Young's modulus of wire by Searle's method.

9.   Determination of rigidity modulus of rod by static method.

        Determination of surface tenson of water by using capillary rise method.

FHMF159	Communicative English Lab	0-0-3	2

Lab sessions will be devoted to practice activities based on all three modules of theory.

a. **phonemic transcription**

Students will be trained to find out the correct pronunciation of words with the help of a dictionary, to enable them to monitor and correct their own pronunciation. i transcription of words and short sentences in normal English orthography (writing) into their IPA equivalents ; ii transcription of words presented orally ; iii conversion of words presented through IPA symbols into normal orthography iv syllable division and stress marking (in words presented in IPA form)

b. **Listening**

i listening with a focus on pronunciation (ear-training) : segmental sounds, stress, weak forms, intonation Students should be exposed, if possible, to the following varieties of English during listening practice : Standard Indian, British and American.

c. **Speaking**

i pronunciation practice (for accent neutralization), particularly of problem sounds, in isolated words as well as sentences ii practising word stress, rhythm in sentences, weak forms, intonation ii reading aloud of dialogues, poems, excerpts from plays, speeches etc. for practice in pronunciation

d. **Grammar and usage**

The focus will be on the elimination of common errors. Some writing activities (e.g. writing of short paragraphs on assigned topics) can be used to identify these errors. Project Work Students will be required to produce and submit by the end of Semester 1 a 350-500 word project report on a topic of their choice. The project should involve data collection, analysis and reporting.

FBEF161	Programming in C lab	0-0-3	2

Experiment No. 1

    a) Write a C program to find the sum of individual digits of a positive integer.

    b) A Fibonacci sequence is defined as follows: the first and second terms in the sequence are 0 and 1. Subsequent terms are found by adding the preceding two terms in the sequence. Write a C program to generate the first n terms of the sequence.

    c) Write a C program to generate all the prime numbers between 1 and n, where n is a value supplied by the user.

Experiment No. 2

    a) Write a C program to calculate the following Sum:

Sum=1-x2
/2! +x4
/4!-x6
/6!+x8
/8!-x10/10!

    b) Write a C program to find the roots of a quadratic equation.

Experiment No. 3

    a) Write C programs that use both recursive and non-recursive functions

i) To find the factorial of a given integer.

ii) To find the GCD (greatest common divisor) of two given integers.

iii) To solve Towers of Hanoi problem.

Experiment No. 4

    a) Write a C program to find both the larges and smallest number in a list of integers.

    b) Write a C program that uses functions to perform the following:

i) Addition of Two Matrices

ii) Multiplication of Two Matrices

Experiment No. 5

    a) Write a C program that uses functions to perform the following operations:

i) To insert a sub-string in to given main string from a given position.

ii) To delete n Characters from a given position in a given string.

    b) Write a C program to determine if the given string is a palindrome or not

Experiment No. 6

    a) Write a C program to construct a pyramid of numbers.

    b) Write a C program to count the lines, words and characters in a given text.

Experiment No.7

    a) Write a C program that uses functions to perform the following operations:

i) Reading a complex number

ii) Writing a complex number

iii) Addition of two complex numbers

iv) Multiplication of two complex numbers

    (Note: represent complex number using a structure.) 21

Experiment No. 8

    a) Write a C program which copies one file to another.

    b) Write a C program to reverse the first n characters in a file.

(Note: The file name and n are specified on the command line.)

Book:- PVN. Varalakshmi, Project Using C Scitech Publish

FCYE108	Chemistry -I	3-0-0	3

Gaseous state: Postulates of Kinetic theory of gases, derivation from ideal behavior, van der walls equation of state. Critical phenomena: PV isotherm of real gases, continuity of states, the isotherms of van der walls equation, relationship between vanderwals constant and critical constants, the law of corresponding states, reduced equation of state **[5hrs]**

Liquid state: Intermolecular forces, structure of liquids (qualitative description), liquid crystals: difference between liquid crystal, solid and liquid. **[2hrs]**

Solid state: space lattice and unit cell. Qualitative description of X-ray diffraction in crystals. Derivation of Braggs eqn., **[2hrs]**

Atomic structure: de-Broglie matter waves, Uncertainty principle, Schrodinger wave equation, quantum numbers and its significance, shape of s, p, d orbitals, electronic configuration of elements.
[3hrs]

Periodic properties: Screening effect, effective nuclear charge, size of atoms and ions, ionization potential, electron affinity, electronegativity, variable valency and oxidation states, horizontal, vertical and diagonal relationship. **[4hrs]**

Chemical bonding: Ionic bond, polarizability, Fajan's rule , lattice energy and Born- Haber cycle, solvation energy and solubility of ionic compounds, **[3hrs]**

Covalent bond: Lewis theory, dipole moment and its application, percentage ionic character from dipole moment and electronegativity, VBT, hybridization,VSEPR theory, MOT(homo and heteronuclear diatomic molecule), Resonance **[5hrs]**

 Metallic bond(free electron and band theories) H-bond, Vanderwaals force. **[3hrs]**

FCYE158	Chemistry Lab -I	0-0-3	2

Qualitative analysis of mixture of inorganic substances containing four ions (including anions like phosphate, fluoride and mixture of anions like carbonate, sulfite, sulfide, nitrate, chloride, bromide, phosphate, arsenate, nitrate, iodate and sulfate and cations of qualitative groups I, II, III, IV, V and VI)

To determine the specific reaction rates of the hydrolysis of the esters by H+ ion at room temp.

To study the effect of acid strength on hydrolysis of the esters

To study kinetically the reaction rate of iodide-H_2O_2 reaction

To study the distribution of iodine between water and CCl_4

To study the distribution of benzoic acid between water and benzene.

FCYC201	Inorganic Chemistry-II	3-0-0	3

Module-I

s-block elements: Comparative study, diagonal relationships, salient features of hydrides, salvation and complexation tendencies including their function in biosystems, an introduction to alkyls and aryls

[4hrs]

Module-II

p-block elements: Comparative study (including diagonal relationship) of group 13-17 elements, compounds like hydrides, oxides, oxyacids and halides of groups 13-16, hydrides of boron-diborane and higher boranes, borazine, boronhydrides, fullerenes, carbides, fluorocarbons, silicates(structural principle), S_4N_4, basic properties of halogens, interhalogens and polyhalides. **[15hrs]**

Module-III

Chemistry of noble gases: Chemical properties, chemistry of xenon, structure and bonding in xenon compounds **[4hrs]**

Module-IV

Chemistry of Elements of First Transition Series

Electronic configuration, Characteristic properties of d-block elements and chemistry of first row transition elements, oxidation states, variable valancies, atomic and ionic radii, electron affinity, electronegativity, ionisation potential, colour and magnetic properties tendency, complex formation, coordination number and geometry. **[7hrs]**

Essential readings:

1. J.D. Lee, Concise Inorganic Chemistry, 5th edition, Blackwell Publishing, 2008
2. Huheey, Keiter and Keiter, Inorganic chemistry Principle, structure and reactivity. 4[Th] edn
3. Inorganic Chemistry R.D.Madan, S.Chand Publication
4. Basic Inorganic Chemistry Cotton & Willikinson

| FCYC203 | Organic Chemistry-I | 3-0-0 | 3 |

Module-I

Nomenclature of Organic molecules: Brief revision, Nomenclature of polycyclic compounds including bridged, spiro and other special structures.   **[2hrs]**

Structure and Bonding: Nature of bonding in aliphatic, alicyclic, aromatic and heterocyclic compounds; Aromaticity in benzenoid and non-benzenoid compounds. Alternant and non-alternant hydrocarbons; Dipole moment   **[6hrs]**

Module-II

Electronic Displacement in Organic Molecules: Inductive and Field effects,Resonance; hyperconjugation, Steric inhibition of resonance, structural effects on acidity and basicity.

Types of reagents-Electrophiles , nucleophiles,Reactive Intermediates-Carbocations; carbanions; free radicals, radical anions and cations; arynes; carbenes and nitrenes (Introduction to structure, stability, and reactions).   **[4hrs]**

Module-III

Reaction Mechanism: Methods of determination of reaction mechanism(product analysis, intermediates,isotope effects,kinetic and stereochemical studies)

Substitution reaction: Aliphatic substitutions: SN1, SN2, SN2' and SNi reactions; neighbouring group participation. Nucleophilic aromatic substitution (brief); Free radical substitutions (both aliphatic and aromatic) reactivity and selectivity of halogenations of alkane,electrophilic aromatic substitution (in detail); addition reaction (detailed stereochemistry of addition of H2, X2,HX type), markownikoff and anti-markownikoff addition,Eliminations: E1, E2, E1CB reactions (in detail),Elimination vs Substitution.

                                        [6hrs]

Module-IV

Stereochemistry: Conformational analysis of acyclic systems (Pitzer strain, A strain, etc.) and cyclohexane systems, axial and equatorial bonds,conformation of mono and disubstituted cyclohexane, Newman projection and sawhorse formula, fisher and flying wedge formula, Introduction of terminologies such as erythro, threo, exo, endo, epimers, etc. Conformational analysis of decalins and other polycyclic compounds related to steroids.

Optical isomerism(in compounds containing more than one chiral centre, in biphenyls, allenes and spiro compounds.),resolution of enantiomers, inversion, racemisation and retention

Relative and absolute configuration, sequence rule,D,L and R,S systems of nomenclature

Geometric isomerism: determination of configuration (cis, trans and E,Z),oximes and alicyclic compounds.   **[12hrs]**

Essential readings:

1. March, J., Advanced Organic Chemistry, 4th ed, 1999.

2. Nasipuri, D., Stereochemistry of Organic Compounds, 2nd ed., 1995.

3. Solomons, T. W. G., Organic Chemistry 6th ed, 1996.

4. Sykes, Peter, A guide book to Mechanism in Organic Chemistry.

5. R. Bruckner, Advanced Organic Chemistry, 2002

6. R. Bruckner, Organic Mechanisms, 2010

7. M. B. Smith, Organic Synthesis, 3rd Ed. 2010

FPYE206	Physics-II	3-0-0	3

Module-I

Scalar and vector triple product. Differentiation of a vector with respect to a scalar. The gradient operator. The divergence and curl of vector. Gauss divergence theorem, Strokes theorem. Gauss law in electrostatics and application, Computation of fiel due to linear spherical and plane charge distribution, Differential form of Gauss law, the energy of a point charge, discrete and continuous distribution,

Module-II

energydensity,dielectrics,Susceptibility,permeability,dielectric constant.Magnetic field B,Lorentz force law,The Biot savart law B due to a straight, circular, and solenoidal currents. The vector potential, Ampere ' circuital law & its differential form. Differential form of electromagnetic induction.
(12)

Module-III

Maxwell equation and physical significance. Wave equation, Electromagnetic waves.wave properties,speed,growth and decay current in RC and LR circuits. Phase diagram,impedance,Power in ac circuit,power factor, series and parallel resonant circuits, Sharpness of resonance, Bandwidth and Q-factor.   (8)

Module-IV

Rectifier:Haif wave & full wave rectifier(semiconductor devices)Principle,circuit,operation & theory.Use of L & π filters in rectifier circuits(qualitative idea)Amplifier: Classification of amplifier,compairsion,Voltage & power gain inCB,CE &CC configuration.RC coupled amplifier, Class B Push/pull amplifier(principle of amplification circuit description operation, theory and frequency response curve)Necessary of feed back ,positive & negative feedback, criteria for sustained oscilation,Hartly and colpitt's oscillator(principle,circuit,operation,th eory and use),feedback Amplifier: Basic circuit,operation,advantage of negative feedback, Modulation & demodulation:Princple of modulation.A.m &F.M(Theory and differences between them).Principle of demodulation Function & basic theory of linear diode detectors.   (10)

Essential readings:
1. Introduction to Electrodynamics- D. J Griffiths (PHI)
2. Foundation of electromagnetic theory- Ritz and Milford (Narosa)
3. Electricity and magnetism- E. Purcell (Berkely Physics Course) TMH
4. Electronics- Chattopadhyay& Rakshit (New Age)
5. Electronics- B. B Swain
6. Electricity and magnetism- D. C Tayal
7. Electricity and magnetism- Satyaprakash

FMCE207	Math-II		3-0-0	3

Module I : (12 Hours)

Bounded and unbounded sets, Infimum and Supremum of a set and their properties, Order completeness property of R, Archimedian property of R, Density of rational and irrational numbers in R.

Neighbourhood, Open set, Interior of a set, Limit point of a set, Closed set, Countable and uncountable sets, Derived set, closure of a set, Bolzano- Weierstrass theorem for sets.

Sequence of real numbers, Bounded sequence, limit points of a sequence, limit interior and limit superior convergent and non-convergent sequences, Cauchy's sequence, Cauchy's general principle of convergence

Module II : (12 Hours)

.Infinite series and its convergence, Test for convergence of positive term series, Comparison test, Ratio test, Cauchy's root test**.**

Preliminary Notations, Group Theory **:** Algebraic structures, Groups, Some Examples of Groups, Subgroups, A Counting Principle, Cosets, Normal Subgroups and Quotient Groups,

Module III: (12 Hours)

Group Homomorphisms, Isomorphisms, Automorphisms, Permutation Groups.

RingTheory : Definition & Example of Rings,Some Special Classes of Rings.

TEXT BOOKS:

1.G. Das & S. Pattnaik : Fundamentals of Mathematical Analysis, TMH

2.Topics In Algebra, by I. N. Herstein, Wiley Eastern.

Ch. 1, Ch. 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8, 2.10, Ch. 3.1, 3.2, 3.3, 3.4

REFERENCE BOOKS:

1.. R. G. Bartle and D.R. Sherbert, Introduction to Real Analysis (4th Edition), Wiley. 2.. K. A. Ross, Elementary Analysis: The Theory of Calculus, Under graduate Texts in Mathematics, Springer (SIE), Indian reprint, 2004.

3. Sudhir R Ghorpade and Balmohan V. Limaye, A course in Calculus and Real Analysis, Undergraduate Text in Math., Springer (SIE). Indian reprint, 2004.

4. Modern Algebra by A. R. Vasishtha,Krishna PrakashanMandir, Meerut.

5.Topics in Algebra by P.N.Arora, Sultan Chand & Sons.

FHMF209	Business Communication English	2-0-0	2

Module – I

The Elements of Business Communication (10 hours) 1.1 patterns of communication in the business world: upward, downward, horizontal, grapevine etc 1.2 internal and external channels of communication; formal and informal channels. 1.3 Introduction to cross-cultural communication. 1.4 avoiding gender, racial and other forms of bias in communication 1.5 common forms of oral and written communication in the business world: Oral presentations, interviews and group discussions Memos, reports, summaries and abstracts, e-mails

Module-II

Reading and writing (15 hours) 2.1 the importance of developing reading skills 2.2 the sub-skills of reading : a. understanding the main idea and supporting details b. reading between the lines : inferential reading c. understanding the writer's point of view d. making predictions e. guessing the meanings of unfamiliar words f. skimming and scanning g. note-making 2.3 the importance of writing skills 2.4 the differences between speech and writing 2.5 the qualities of effective writing : coherence, cohesion, logical structuring and organization, clarity of language, stylistic variation etc. 2.6 the writing process : pre-writing, drafting, re-writing 2.7

Module –III

Soft skill development (5 hours) 4.1 soft skills: becoming a good leader and team-player 4.2 inter-relating soft skills and communication skills

Text Books:
1. Business Communication Today by Bovee et al (Pearson)
2. Business Communication by Meenakshi Raman and Prakash Singh (Oxford)

RecommendedBooks :
1. Crash Course in Personal Development by Brian Clegg (Kogan Page)
2. Activities for Developing Emotional Intelligence by Adele B.Lynn (HRD Press)
3. Lateral Thinking by Edward De Bono (Penguin)

FBEF210	Data structure using C	3-0-0	3

Module I (10 hrs)
Introduction to object oriented programming, user defined types, structures, unions, polymorphism, encapsulation. Getting started with C++ syntax, data-type, variables, strings, functions, default values in functions, recursion, namespaces, operators, flow control, arrays and pointers.

Module II (12 hrs)
Abstraction mechanism: Classes, private, public, constructors, destructors, member data, member functions, inline function, friend functions, static members, and references.
Inheritance: Class hierarchy, derived classes, single inheritance, multiple, multilevel, hybrid inheritance, role of virtual base class, constructor and destructor execution, base initialization using derived class constructors.
Polymorphism: Binding, Static binding, Dynamic binding, Static polymorphism: Function Overloading, Ambiguity in function overloading, Dynamic polymorphism: Base class pointer, object slicing, late binding, method overriding with virtual functions, pure virtual functions, abstract classes.
Operator Overloading: This pointer, applications of this pointer, Operator function, member and non member operator function, operator overloading, I/O operators.
Exception handling: Try, throw, and catch, exceptions and derived classes, function exception declaration.

Module III (08 hrs)
Dynamic memory management, new and delete operators, object copying, copy constructor, assignment operator, virtual destructor.
Template: template classes, template functions.
Namespaces: user defined namespaces, namespaces provided by library.

Text Books:

1. Object Oriented Programming with C++ - E. Balagurusamy, McGraw-Hill Education (India)
2. ANSI and Turbo C++ - Ashoke N. Kamthane, Pearson Education

Reference Books:
1. Big C++ - Wiley India
2. C++: The Complete Reference- Schildt, McGraw-Hill Education (India)
3. "C++ and Object Oriented Programming" – Jana, PHI Learning.
4. "Object Oriented Programming with C++ "- Rajiv Sahay, Oxford
5. Mastering C++ - Venugopal, McGraw-Hill Education (India)
6. "Object Oriented Programming with C++", David Parsons, Cengage Learning.

FCYC251	Chemistry Lab -II	0-0-3	2

Determination of melting point of naphthalene, benzoic acid, urea, succinic acida, salicylic acid

Determination of boiling point of ethanol, cyclohexane,toluene, benzene

Determination of melting point of urea-cinnamic acid mixture of various composition

Detection of extra elements (N S and halogen), functional groups containing C,H,O C,H,N in organic compounds.

Determination of acetic acid in commercial vinegar using NaOH

Determination of alkali content in antacid tablet using HCl

Estimation of Hardness of water by EDTA

Estimation of calcium in chalk

Estimation of Fe(II) and FE(III) by dichromate method

Estimation of Cu using thiosulphate

Gravimetric analysis of Cu as CuSCN

Gravimetric analysis of Ni as Ni(dimethylglyoxime)

Essential readings:

1. R.C. Das and B. Behera , Experimental Physical Chemistry, , Tata McGraw Hill 2000
2. G. Svehla, Vogel's qualitative inorganic analysis, Harlow Longman, 2002.
3. A I Vogel, John Bassett, Vogel's textbook of quantitative inorganic analysis: including elementary instrumental analysis, Longman,2003
4. D. Alart, Practical Physical Chemistry, Longman, 1993.
5. A I Vogel , Qualitative Inorganic Analysis, Orient Longman – 1979.

FPYE256	Physics Lab-II	0-0-3	2

1. Determination of wavelength of sodium light by using Newton's ring method.
2. Determination of grating element of grating spectra.
3. Determination of wave length of Laser.
4. Determination of magnifying power of a microscope.
5. Determination of magnifying power of a telescope.
6. Determination of High resistance using Galvanometer.
7. Figure of merit of a Galvanometer.
8. Resistance of a resistor using meterbridge (applying end correction).
9. Determination of wavelength of a monochromatic light using Bi-prism and optical bench.
10. Determination of refractive index of a prism by I-D curve method using spectromethod.

FHMF259	Business Communication English Lab	0-0-3	2

a. Communication Practice 30 hours i Speaking : oral communication in social and 10 hours work-related situations, e.g.: Greeting an acquaintance/ friend, introducing oneself, introducing a friend to another friend, breaking off a conversation politely, leave-taking; making and responding to inquiries; expressing an opinion; expressing agreement/ disagreement, contradicting/ refuting an argument; expressing pleasure, sorrow, regret, anger, surprise, wonder, admiration, disappointment etc. Narrating or reporting an event; Describing people, objects, places, processes etc. Ordering / directing someone to do something Making requests; accepting / refusing a request Expressing gratitude; responding to expressions of gratitude Asking for or offering help; responding to a request for help Asking for directions (e.g. how to reach a place, how to operate a device etc.) and giving directions asking for and granting/ refusing permission prohibiting someone from doing something suggesting, advising, persuading, dissuading, making a proposal praising, complimenting, felicitating expressing sympathy (e.g. condolence etc.) Complaining, criticizing, reprimanding ii Reading 10 hours Students will be given practice in reading and comprehending 6-8 simple passages of 100-300 words each, on topics of general as well as professional interest. The texts will be supported by suitable exercises designed to foster comprehension skills and vocabulary enrichment, together with study skills (note making) and reference skills (using a dictionary). Practice will be provided in the important sub-skills of reading which are introduced in Module 2 of the theory component. iii Writing 10 hours Writing short paragraphs on given topics or topics of one's choice; social and business letters; reports; applications ; resumes ; summaries The principles of 'Process Writing' should be used to teach writing skills. i pre-writing : generating ideas, brain-storming, idea mapping, outlining ii writing : generating a first draft ; reviewing, redrafting, editing iii post-writing : making a presentation ; discussion and feedback, preparing the final draft b. Soft skills practice 10 hours Activities designed to highlight leadership and 'team' skills ; Group discussion

FBEF260	Data structure using C Lab	0-0-3	2

Experiment No.1 Write a C program to perform matrix multiplication using array.

Experiment No.2 (a) Write a C program to create a stack using an array and perform (i) push operation (ii) pop operation (b) Write a C program to create a queue and perform i) Push ii) pop iii) Traversal

Experiment No. 3 Write a C program that uses Stack operations to perform the following: i) Converting infix expression into postfix expression ii) Evaluating the postfix expression

Experiment No. 4 Write a C program that uses functions to perform the following operations on Single linked list: i) Creation ii) Insertion iii) Deletion iv) Traversal in both ways

Experiment No. 5 Write a C program that uses functions to perform the following operations on Double linked list: i) Creation ii) Insertion iii) Deletion

Experiment No. 6 Write a C program that uses functions to perform the following operations on Binary Tree: i) Creation ii) Insertion iii) Deletion

Experiment No. 7 Write C programs that use both recursive and non recursive functions to perform the Linear search operation for a Key value in a given list of integers: i) Linear search

Experiment No. 8 Write C program that use both recursive and non recursive functions to perform the Binary search operation for a Key value in a given list of integers:

Experiment No.9 Write a C program that implement Bubble Sort method to sort a given list of integers in descending order.

Experiment No.10 Write a C program that implement Quick Sort method to sort a given list of integers in ascending order:

Book:- "Data structure using C" by Sudipta Mukherjee, TMH Publication

FCYE208	Chemistry -II	3-0-0	3

Nomenclature of Organic molecules: Brief revision, Nomenclature of polycyclic compounds including bridged, spiro and other special structures. **[2hrs]**

Structure and Bonding: Nature of bonding in aliphatic, aromatic compounds; Aromaticity in benzenoid and non-benzenoid compounds. Inductive and Field effects,Resonance; hyperconjugation, structural effects on acidity and basicity. **[3hrs]**

Types of reagents-Electrophiles , nucleophiles,Reactive Intermediates-Carbocations; carbanions; free radicals, radical anions and cations; (Introduction to structure, stability, and reactions). **[3hrs]**

Stereochemistry: Conformational analysis of acyclic systems and cyclohexane systems, axial and equatorial bonds,conformation of monosubstituted cyclohexane, Introduction of terminologies such as erythro, threo, exo, endo, epimers, etc. Optical isomerism(in compounds containing more than one chiral centre, in biphenyls, allenes and spiro compounds.),resolution of enantiomers, inversion, racemisation and retention

Relative and absolute configuration, sequence rule,D,L and R,S systems of nomenclature

Geometric isomerism: determination of configuration (cis, trans and E,Z),oximes and alicyclic compounds. **[5hrs]**

Reaction mechanism: Substitution reaction: Aliphatic substitutions: SN1, SN2, reactions; Free radical substitutions ,electrophilic aromatic substitution (idea only); addition reaction (addition of H2, X2,HX type), markownikoff and anti-markownikoff addition,Eliminations: E1, E2, **[6hrs]**

Chemical Kinetics and catalysis: Rates of reactions, factors influencing rates of reaction- conc., temp, press, solvent, light, catalyst. (Arrehenius eqn. concept of activation energy), collision theory of reaction rates, Order and molecularity, mathematical characteristics of simple chemical reactions-zero order, first order, second order, pseudo order, half and mean life. Determination of the order of reaction (differential method, half life period method,method of isolation and integration)

Catalysis: characteristic of catalysed reactions, classification of catalysis **[10hrs]**

| FCYE258 | Chemistry Lab -II | 0-0-3 | 2 |

To determine the percentage composition of a given mixture(non-reacting system) by viscosity method.

To determine the viscosity of amyl alcohol in water at different concentrations and calculation of excess viscosity of these solutions

To determine the percentage composition of a given binary mixture (acetone and ethylmethyl ketone) by surface tension method.

Estimation of Ca^{2+} and Mg^{2+} by EDTA

Determination of pH of a buffer solution

Determination of viscosity of a lubricating oil.

Determination of flash and fire point of an oil by Pensky-Marten apparatus.

Determination of concentration of a coloured solution by a spectrophotometer.

FCYC301	Organic Chemistry-II	3-0-0	3

Module-I

Compounds containing active methylene groups: Introduction, Keto-enoltautomerism, acidic character of such compounds

Preparation and Application towards the synthesis of monocarboxylic acid, dicarboxylic acid, keto acids, ketones, diketones, Unsaturaed acids, heterocyclic compounds etc. of aceto acetic ester and malonic ester.

Module-II

Organometallic Compounds -I

Grignards' Reagent: Preparation, Reaction of compounds containing active hydrogen, carbonyl compounds, epoxides, carbon dioxide, nitriles, oxygen, sulphure, carbon disulphide, sulphure dioxide, iodine, inorganic halides, alkyl halides, α-unsaturated carbonyl compounds.

Organolithium compounds: Preparation, Reaction of compounds containing active hydrogen, carbonyl compounds, alkenes, carbon dioxide, nitriles, electrophilic displacement, nucleophilic displacement, α-β unsaturated carbonyl compounds.

Organocopper compounds: Preparation, Reaction with alkyl or aryl halides, epoxides, acid chlorides, α-unsaturated carbonyl compounds.

Module-III

Organometallic Compounds -II

Organozinc compounds: Preparation, Reaction with water, alkyl halides, acid chlorides.
Organoaluminium compounds: Preparation and reaction.

Module-IV

Heterocyclic Compounds: Introduction, Structure and aromaticity, Preparation and properties of Five membered Heterocyclic compounds(Pyrrole, Furan and Thiophene), Six membered Heterocyclic compounds(Pyridine) and fused Heterocyclic system(Quinoline)

Essential readings:

1. Organometallic in Organic Chemistry by J. M. Swan and D. St. C. Black
2. Organic reaction mechanism, Third edition, V.K.Alluwalia, R.K.Parashar, NarosaPublising House.
3. Organic Chemistry, Second Edition, Mehta & Mehta, Eastern Economy Edition

| FCYC302 | Physical Chemistry-II | 3-0-0 | 3 |

Module-I
Thermodynamics – I
Basic ideas on first law of thermodynamics and thermo-chemistry, Heat capacity, heat capacities at constant volume and pressure and their relationship. Joule's law – Joule-Thompson coefficient and inversion temperature. Calculation of w, q, dU and dH for the expansion of ideal gases under isothermal and adiabatic conditions for reversible process, Kirchhoff's equation.

Module-II
Thermodynamics – II
Second law of thermodynamics: need for the law, different statements of the law. Carnot cycle and its efficiency, Carnot theorem.Thermodynamic scale of temperature.
Concept of entropy. Entropy as a state function, entropy as a function of V & T, entropy as a function of P & T, entropy change in physical change, Clausius inequality, entropy as criteria of spontaneity and equilibrium. Entropy change in ideal gases and mixing of gases.

Module-III
Thermodynamics – II
Third law of thermodynamics: Nernst heat theorem, statement and concept residual entropy, evaluation of absolute entropy from heat capacity data. Gibbs and Helmholtz functions; Gibbs function (G) and Helmholtz function (A) as thermodynamic quantities, A & G as criteria for thermodynamic equilibrium and spontaneity, their advantage over entropy change. Variation of G and A with P, V and T.

Module-IV
Chemical Equilibrium
Equilibrium constant and free energy.Thermodynamic treatment of law of mass action. Relationship between K_p, K_c and K_x. Homogeneous equillibria, Temperature dependence of equilibrium constant, Heterogeneous equillibria, Le Chaterlier'sprinciple.Reaction isotherm and reaction isochore – Clapeyron equation and Clausius – Clapyron equation, applications.

Essential readings:
1 The Elements of Physical Chemistry by P. Atkins, Oxford University Press
2 Principles of Physical Chemistry by Puri, Sharma and Pathania, Vishal Publication Co

| FPYE306 | Physics –III | 3-0-0 | 3 |

Module-I

Thermodynamic system and thermodynamic equilibrium, Reversible and irreversible process ,internal energy, first law of thermodynamics, difference between molar specific heat of an ideal gas, Derivation of relation PV^γ =constant for adiabatic process, work done in isothermal and adiabatic process.Entropy change in various processes.T-S diagram, Carnot cycle , Carnot engine and its efficiency ,Carnot theorem, second law of thermodynamics-Kelvin plank and Clausius formulation, their quivalence, thermodynamic scale of temperature.   (7)

Module-II

Thermodynamic co-ordinates P.V.T and1st Tds equation, 2nd Tds equation . Clausius- Clapeyron equation, effect of pressure on melting point and boiling point,thermal conductivity,differential equation of heat flow in one dimension,experimental determination of of thermal conductivity by Ingen-Haus and Searl's method. Vandewall's equation of state   for real gases, critical constants, reduced equation of state.(7)

Module-III

Black body radiation,Stefans law, energy distribution in the blackbody spectrum. Wien' displacement law,Wein's formula and Rayleigh –jeans formula (only statement and discussion).Planck' radiation formula, derivative of Rayleigh-jeans formula.Wein's formula and Stefan Boltzmann law using Planck's formula. Rutherford's atomic model and its short coming, Bohr's theory of hydrogen atom. Energy levels,explanation   of spectra,correction for nuclear motion,Bohr's correspondence principal.Frank-Hertz experiment, critical potential. Photoelectric effect, Photon,Einstein's photoelectric effect, photon ,Einstein's photoelectric equation, Compton effect. Particle nature of radiation.(8)

Module-IV

The atomic nucleus:its size,mass,charge, spin,magnetic moment, Mass defect ,binding energy, stability of nuclear force-its characterstics,Radioactive decay law, activity decay law,activity,half-life, average life, elementary idea of nuclear fission and fusion. Linear accelerator, cyclotron. (8)

Essential readings:

1. Heat and Thermodynamics-A.B.Gupta& H.B. Ray(New Central)
2. Sound-M.Ghosh (S.Chand)
3. Physics for degree students-vol-I, II, M.Das
4. Modern Physics-R.Murugeshan
5. Introduction   to Modern physics-H.S. Mani, G.K. Mehta (Affiliated East West)
6. Atomic physics-G.P.Harnwerll & W.E. Stephens.Mc Graw-HILL book company,Inc.
7. Atomic and nuclear physics-Satyapraksh
8. Atomic and nuclear physics-Shatendra Sharma (pearson publication)
9. Atomic and nuclear physics-Gupta Ghosha

FMCE307	Math –III	3-0-0	3

MODULE-I (14 Hours)

Asymptotes in Cartesian coordinates, intersection of curve and its asymptotes, asymptotes in polar coordinates, curvature, radius of curvature for Cartesian curves, polar curves, Newton's method, centre of curvature, circle of curvature .

MODULE-II(13 Hours)

Points of inflexion, Multiple points, Cusp, Nodes & conjugate points, Types of cusps, Tracing of curves in Cartesian, Parametric, and Polar coordinates .Trace (Folium of Descartes, Strophoid, Astroid, Cycloid, Cardioids, Lemniscates of Bernoulli)

MODULE-III(13 Hours)

General equation of the Sphere, intersection of a sphere and a plane, intersection of two spheres, family of spheres, Intersection of a sphere and a line, Tangent plane ,condition of tangency, equation of a cone , Enveloping cone of a sphere ,cylinder, Enveloping cylinder of a sphere, Right circular cone & cylinder.

Essential readings:

1. Differential Calculus by Shanti Narayan & P K Mittal , S.Chand Publication Chapters: 14 (14.1-14.5), 15, 16, 17
2. Analytical Geometry of Quadratic Surfaces by B P Acharya & D C Sahu Chapters: 2 ,3
3. Analytical Solid Geometry by Shanti Narayan
4. Topics in Calculus by Panda Satapathy

FHMF309	Organizational Behaviour	3-0-0	3

Module I [10 hours]: The study of Organizational Behaviour : Definition and Meaning, Why Study OB Learning – Nature of Learning, How Learning occurs, Learning and OB. Foundations of Individual Behaviour : Personality – Meaning and Definition, Determinants of Personality, Personality Traits, Personality and OB. Perception – Meaning and Definition, Perceptual Process, Importance of Perception in OB. Motivation – Nature and Importance, Herzberg's Two Factor Theory, Maslow's Need Hierarchy Theory, Alderfer's ERG Theory, Evaluations.

Module II [10 hours]: Organizational Behaviour Process : Communication – Importance, Types, Gateways and Barriers to Communication, Communication as a tool for improving Interpersonal Effectiveness, Groups in Organizations – Nature, Types, Why do people join groups, Group Cohesiveness and Group Decision-making Managerial Implications, Effective Team Building. Leadership-Leadership & Management, Theories of Leadership-Trait theory, Leader Behaviour theory, Contingency Theory, Leadership and Followership, How to be an effective Leader, Confict-Nature of Conflict and Conflict Resolution. An Introduction to Transactional Analysis (TA).

Module-III [10 hours]: Organization : Organizational Culture – Meaning and Definition, Culture and Organizational Effectiveness. Introduction to Human Resource Management-Selection, Orientation, Training and Development, Performance Appraisal, Incentives Organizational Change – Importance of Change, Planned Change and OB techniques. International OrganisationalBehaviour – Trends in International Business, Cultural Differences and Similarities, Individual and Interpersonal Behaviour in Global Perspective.

Essential readings:

1. Keith Davis, OrganisationalBehaviour, McGraw-Hill.
2.   K.Aswathappa, OrganisationalBehaviour, Himalaya Publishing House.
3. Stephen P. Robbins, OrganisationalBehaviour, Prentice Hall of India
4. Pradip N. Khandelwal, Organizational Behaviour, McGraw-Hill, New Delhi.
5. Uma Sekaran, "Organizational Behaviour", TATA McGraw-Hill, New Delhi.
6. Steven L McShane, Mary Ann Von Glinow, Radha R Sharma" Organizational Behaviour" , TATA McGraw- Hill.
7. D.K. Bhattachayya, "Organizational Behaviour", Oxford University Press
8. K.B.L.Srivastava&A.K.Samantaray, "Organizational Behaviour" India Tech.

FBEF311	OOPS using C++	3-0-0	3

Module I

Introduction to object oriented programming, user defined types, structures, unions, polymorphism, encapsulation. Getting started with C++ syntax, data-type, variables, strings, functions, default values in functions, recursion, namespaces, operators, flow control, arrays and pointers.

Module II

Abstraction mechanism: Classes, private, public, constructors, destructors, member data, member functions, inline function, friend functions, static members, and references.

Inheritance: Class hierarchy, derived classes, single inheritance, multiple, multilevel, hybrid inheritance, role of virtual base class, constructor and destructor execution, base initialization using derived class constructors.

Polymorphism: Binding, Static binding, Dynamic binding, Static polymorphism: Function Overloading, Ambiguity in function overloading, Dynamic polymorphism: Base class pointer, object slicing, late binding, method overriding with virtual functions, pure virtual functions, abstract classes.

Operator Overloading: This pointer, applications of this pointer, Operator function, member and non member operator function, operator overloading, I/O operators.

Exception handling: Try, throw, and catch, exceptions and derived classes, function exception declaration.

Module III

Dynamic memory management, new and delete operators, object copying, copy constructor, assignment operator, virtual destructor.

Template: template classes, template functions.

Namespaces: user defined namespaces, namespaces provided by library.

Essential readings:

1. Object Oriented Programming with C++ - E. Balagurusamy, McGraw-Hill Education (India)
2. ANSI and Turbo C++ - Ashoke N. Kamthane, Pearson Education
3. Big C++ - Wiley India
4. C++: The Complete Reference- Schildt, McGraw-Hill Education (India)
5. C++ and Object Oriented Programming – Jana, PHI Learning.
6. Object Oriented Programming with C++ - Rajiv Sahay, Oxford

FCYC351	Chemistry Lab -III	0-0-3	2

1. Acid-base titration using pH meter (only HCl)

2 Acid-base titration using pH meter (mixture, HCl and CH3COOH)

3. Acid-base titration using conductivity meter (only HCl)

4. Acid-base titration using onductivity meter (mixture, HCl and CH3COOH)

5. Determination of cell constant of a conductivity cell.

6. Determination of equivalent conductance at infinite dilution of a strong electrolyte.

7. Determination of critical micellar concentration(CMC) by using conductivity meter.

Essential readings:

1. R.C. Das and B. Behera , Experimental Physical Chemistry, , Tata McGraw Hill 2000
2. D. Alart, Practical Physical Chemistry, Longman, 1993.

FPYE356	Physics Lab-III	0-0-3	2

1. Young's modulus by bending of beam by cantilever.

2. Coefficient of viscosity by viscometer.

3. Determination of Young's modulus, modulus of rigidity, and poissons ratio of material of a wire using Searle's method.

4. Error analysis using vernier callipers, screw gauge and spherometer.

5. Specific resistance of the given material of the wire using Carey foster

6. Determination of g by Kater's pendulum

7. Determination of rigidity modulus of a wire by dynamic method.

8. Mechanical equivalent of heat by Joule's calorimeter.

9. Velocity of sound by resonance column method

10. Thermal conductivity of a bad conductor by lee's method.

FBEF361	OOPS using C++ Lab	0-0-3	2

1. Programs on concept of classes and objects
2. Programs using inheritance
3. Programs using static polymorphism
4. Programs on dynamic polymorphism
5. Programs on operator overloading
6. Programs on dynamic memory management using new, delete operators
7. Programs on copy constructor and usage of assignment operator
8. Programs on exception handling
9. Programs on generic programming using template function & template class
10. Programs on file handling

FCYE308	Chemistry -III	3-0-0	3

Compounds containing active methylene groups: Introduction, Keto-enoltautomerism, acidic character of such compounds

Preparation and Application towards the synthesis of monocarboxylic acid, dicarboxylic acid, keto acids, ketones, diketones, Unsaturaed acids, heterocyclic compounds etc. of aceto acetic ester and malonic ester.

Organometallic Compounds:

Grignards' Reagent: Preparation, Reaction of compounds containing active hydrogen, carbonyl compounds, epoxides, carbon dioxide, nitriles, oxygen, sulphure, carbon disulphide, sulphure dioxide, iodine, inorganic halides, alkyl halides, α-β unsaturated carbonyl compounds.

Organolithium compounds: Preparation, Reaction of compounds containing active hydrogen, carbonyl compounds, alkenes, carbon dioxide, nitriles, electrophilic displacement, nucleophilic displacement, α-β unsaturated carbonyl compounds.

Heterocyclic Compounds: Introduction, Structure and aromaticity, Preparation and properties of Five membered Heterocyclic compounds(Pyrrole, Furan and Thiophene), Six membered Heterocyclic compounds(Pyridine) and fused Heterocyclic system(Quinoline)

FCYE358	Chemistry Lab -III	0-0-3	2

1. Acid-base titration using pH meter (only HCl)

2 Acid-base titration using pH meter (mixture, HCl and CH3COOH)

3. Acid-base titration using conductivity meter (only HCl)

4. Acid-base titration using onductivity meter (mixture, HCl and CH3COOH)

5. Determination of cell constant of a conductivity cell.

6. Determination of equivalent conductance at infinite dilution of a strong electrolyte.

7. Determination of critical micellar concentration(CMC) by using conductivity meter.

FCYC401	Inorganic Chemistry-III	3-0-0	3

Module-I

Chemistry of Elements of Second and Third Transition Series

General Characteristics, comparative treatment with their 3d-analogous in respect of ionic radii, oxidation states, magnetic behaviour, spectral properties and stereochemistry. **[3hrs]**

Chemistry of Elements of Lanthanide Elements

Electronic structure, oxidation states and ionic radii and lanthanide contraction, complex formation, occurrence and isolation, lanthanide compounds **[3hrs]**

Chemistry of Elements of Actinides

General features and chemistry of actinides, chemistry of separation of Np, Pu and Am from U, similarities between the latter actinides and latter lanthanides **[3hrs]**

Module-II

Coodination compounds

Warner's coordination theory and its experimental verification, effective atomic number concept, chelates, nomenclature of coordination compounds, isomerism in coordination compounds, valence bond theory of transition metal complexes. **[6hrs]**

Module-III

Metal –Ligand Bonding in Transition Metal Complexes

Limitations of valence bond theory, an elementary idea of crystal field theory, crystal field splitting in octahedral, tetrahedral and square planar complexes, factors affecting the crystal-field parameters.

[8hrs]

Module-IV

Organometallic Chemistry (07Hrs)

Definition, nomenclature and classification of organometallic compounds. Preparation, properties, bonding and applications of alkyls and aryls of Li, Al, Hg, Sn, a brief account of meta-ethylenic complexes and homogeneous hydrogenation, mononuclear carbonyls and the nature of bonding in metal carbonyls. **[7hrs]**

Essential readings:

1. J.D. Lee, Concise Inorganic Chemistry, 5th edition, Blackwell Publishing, 2008
2. Huheey, Keiter and Keiter, Inorganic chemistry Principle, structure and reactivity. 4Thedn
3. Inorganic Chemistry R.D.Madan, S.Chand Publication
4. Basic Inorganic Chemistry Cotton &Willikinson

| FCYC403 | Organic Chemistry-III | 3-0-0 | 3 |

Module-III
Carbohydrates

Classification and nomenclature.Monosaccharides, mechanism of osazone formation, interconversion of glucose and fructose, chain lengthening and shortening of aldoses.Configuration of monosaccharides.Erythro and threodiastereomers.Conversion of glucose into mannose.Formation of glycosides, ethers and esters.Determination of ring size of monosaccharides. Cyclic structure of D(+)-glucose . Mechanism of mutarotation.
Structure of ribose and deoxyribose.
An introduction to disaccharides (maltose, sucrose and lactose) and polysaccharides (starch and cellulose) without involving structure determination.

[8hrs]

Module-III
Amino acids, Peptides, Proteins and Nucleic acids

Classification, structure and stereochemistry of amino acids.Acid-base behaviour, isoelectric point and electrophoresis.Preparation and reactions of α-amino acids.
Structure and nomenclature of peptides and proteins.Classification of proteins. Peptide structure determination, end group analysis, selective hydrolysis of peptides. Classical peptide synthesis, solid-phase peptide synthesis.Structures of peptides and proteins.
Levels of protein structures.Protein denaturation/renaturation.
Nucleic acids: introduction. Constituents of nucleic acids.Ribonucleosides and ribonucleotides.The double helical structure of DNA. **[8hrs]**

Module-III
Fats, Oils and Detergents

Natural fats, edible and industrial oils of vegetable origin, common fatty acids, glycerides, hydrogenation of unsaturated oils.Saponification value, iodine value, acid value.Soaps, synthetic detergents, alkyl ans aryl sulphonates.

Synthetic dyes

Colour and constitution (electronic concept).Classification of dyes. Chemistry and synthesis of Methyl orange, Congo red, Malachite green, Crystal violet, Phenolphthalein, Fluorescein, Alizarin and Indigo.

[8hrs]

Module-III
Synthetic polymers (04 Hrs)

Addition or chain-growth polymerization. Free radical vinyl polymerization, ionic vinyl polymerization. Ziegler-Natta polymerization and vinyl polymers.
Condensation or step growth polymerization. Polysters, polyamides, phenol formaldehyde resins, urea formaldehyde resins, epoxy resins and polyurethanes.
Natural and synthetic rubbers. **[6hrs]**

Essential readings:
1   Principles of Bio-Chemistry – Lehinger, Nelson and Cox
2   Fundamentals of Bio-Chemistry – Voet&Voet
3   Bio-Chemistry by Zubay
4   Bio-Chemistry, Rastogi, Tata McGraw Hill

FPYE406	Physics-IV	3-0-0	3

Module-I (7hrs)

Fermat's principle, reflection and refraction at plane interference, cardinal points of a coaxial optical system, cardinal points of (i)combination of two thin lenses and (ii) thick lens, elementary ideas of monochromatic aberrations and remedies, chromatic aberration, achromatic combination, removal of chromatic aberration in a separated doublet, Ramsden's and Huygens's eyepieces,

Module-II (8hrs)

Wave theory of light,Huygen's principle, reflection and refraction at plane surfaces, condition of interference, division of wave front,biprism,interference by plane parallel thin film illuminated by a point source, colour of thin films, Newton's ring, determination of wave length of monochromatic light by Newton's ring.

Module-III (7hrs)

Diffraction of light, Fresnel and Fraunhoffer diffraction, Fresnel's half period zones, Zone plate act as a convex lens. Fraunhoffer diffraction by a single slit, double slit Plane transmission grating.

Electromagnetic nature of light, Polarized and unpolarized light. Plane polarized, circularly polarized and elliptically polarized light. Polarization by reflection and refraction, Brewster's law, Malus's law. Double refraction, ordinary and extraordinary rays, construction, working and uses of Nicol prism. Half wave plate and quarter wave plate.

Module-IV (8hrs)

Inadequacy of classical physics: review of black body radiation. Particle nature of wave, photoelectric effect, Compton effect, dual nature of radiation. Wave nature of particle – De Broglie hypothesis and wave-particle duality. Superposition of two waves, group velocity and phase velocity, wave packet. Experimental confirmation of matter waves (Davisson – Germer experiment). Heisenberg's uncertainty principle and applications (Ground state energy of harmonic oscillator and hydrogen atom. Time dependent Schrodinger equation in one and three dimension. The wave function, equation of continuity, probability current density and probability density. Normalization of the wave function, Expectation value of an observable

Essential readings:
1. optics- A.K. Ghatak
2. Principle of optics – B.K.Mathur
3. Optics – P.K. Chakravarty
4. Physics for degree students – VOL III and IV (Srikrishna Prakashan)
5. Introduction to Quantum mechanics – M. Das, P.K.Jena (Srikrishna Prakashan)
6. Quantum mechanics –J.L. Powell, B. Crasemann

FMCE407	Math-IV		3-0-0	3

MODULE-I(14 Hours)

Errors ,Algorithims and Convergence,Transcendental and polynomial equations: Introduction, Bisection method, Regula-falsi method, Secant method, Fixed Point iteration, Newton-Raphson method, Rate of convergence .Error Analysis for iterative methods,

System of Linear Algebraic Equations:Pivoting Strategies, Matrix inversion, LU-Decomposition , Gauss Jacobi, Gauss –Seidel Method , Relaxation Techniques.

MODULE-II(14 Hours)

Interpolation and Approximations: Introduction ,Langrages and Newton Interpolation, Least Square Approximation, Uniform Approximation.Differentiation .

MODULE-III(12 Hours)

Numerical Integration : Newton Cotes Algorithm, Trapezoidal rule, Simpson's rule, Gauss – Legendre Integration Method, Ordinary Differential Equations: Euler's Method ,Euler Modified Method, Runge - kutta Method.

Essential readings:
1. Numerical Mathematics and Computing : by W. Cheney, David Kincaid, Cengage.
2. Numerical Methods by B.P. Acharya & R.N. Das.
3. Numerical Methods for Scientific and Engineering Computation; M.K. Jain,S.R.K. Iyengar, R.K. Jain.
4. A Introduction to Numerical Analysisby K.Aitkinson ,Wiley

FHMF409	Economics	3-0-0	3

Module-I: **(10 hours)** Engineering Economics – Nature and scope, General concepts on micro & macro economics. The Theory of demand, Demand function, Law of demand and its exceptions, Elasticity of demand, Law of supply and elasticity of supply. Determination of equilibrium price under perfect competition (Simple numerical problems to be solved). Theory of production, Law of variable proportion, Law of returns to scale.

Module-II: (10 hours) Time value of money – Simple and compound interest, Cash flow diagram, Principle of economic equivalence. Evaluation of engineering projects – Present worth method, Future worth method, Annual worth method, internal rate of return method, Costbenefit analysis in public projects. Depreciation policy, Depreciation of capital assets, Causes of depreciation, Straight line method and declining balance method.

Module-III: (10 hours) Cost concepts, Elements of costs, Preparation of cost sheet, Segregation of costs into fixed and variable costs. Break-even analysis-Linear approach. (Simple numerical problems to be solved) Banking: Meaning and functions of commercial banks; functions of Reserve Bank of India. Overview of Indian Financial system.

Essential readings:
1. Riggs, Bedworth and Randhwa, "Engineering Economics", McGraw Hill Education India.
2. M.D. Mithani, Principles of Economics.
3. Sasmita Mishra, "Engineering Economics & Costing ", PHI
4. Sullivan and Wicks, " Engineering Economy", Pearson
5. R.PaneerSeelvan, " Engineering Economics", PHI
6. Gupta, " Managerial Economics", TMH 5. Lal and Srivastav, " Cost Accounting", TMH

FBEF411	RDBMS	3-0-0	3

Module I : (10 hours)
Database System Architecture - Data Abstraction, Data Independence, Data Definitions and Data Manipulation Languages. Data models - Entity Relationship(ER), Mapping ER Model to Relational Model, Network .Relational and Object Oriented Data Models, Integrity Constraints and Data Manipulation Operations.

Module II : (10 hours)
Relation Query Languages, Relational Algebra and Relational Calculus, SQL.
Relational Database Design: Domain and Data dependency, Armstrong's Axioms, Normal Forms, Dependency Preservation, Lossless design.
Query Processing Strategy.

Module III: (10 hours)
Transaction processing: Recovery and Concurrency Control. Locking and Timestamp based Schedulers.
Database Recovery System: Types of Data Base failure & Types of Database Recovery, Recovery techniques

Essential readings:
1. Database System Concepts by Sudarshan, Korth (McGraw-Hill Education)
2. Fundamentals of Database System ByElmasari&Navathe- Pearson Education
3. An introduction to Database System – Bipin Desai, Galgotia Publications
4. Database System: concept, Design & Application by S.K.Singh (Pearson Education)
5. Database management system by leon&leon (Vikas publishing House).
6. Fundamentals of Database Management System – Gillenson, Wiley India
7. Database Modeling and Design: Logical Design by Toby J. Teorey, Sam S. Lightstone, and Tom Nadeau, "", 4[th]Edition, 2005, Elsevier India Publications, New Delhi

FCYC451	Chemistry Lab -IV	0-0-3	2

1. Detection of extra elements (N S and halogen),
2. Detection of functional groups containing C,H,O C,H,N in organic compounds
3. Determination of unknown organic compound
4. Organic preparations:
5. Oxidation of ethanol/ isopropanol (Iodoform reaction).
6. Hydrolysis of amides and esters.

Essential readings:

1. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009)
2. Furniss, B.S., Hannaford, A.J., Smith, P.W.G. & Tatchell, A.R. Practical Organic Chemistry, 5th Ed. Pearson (2012)
3. Ahluwalia, V.K. & Aggarwal, R. Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis, University Press (2000).
4. Ahluwalia, V.K. & Dhingra, S. Comprehensive Practical Organic Chemistry: Qualitative Analysis, University Press (2000).

FPYE456	Physics Lab-IV	0-0-3	2

1. Angle of minimum deviation (I-D curve) using spectrometer.

2. Determination of magnifying power of a microscope.

3. Comparison of emf's using stretched wire potentiometer.

4. Thermal conductivity of a bad conductor by lee's method.

5. Optical rotation of sugar solution by polarimeter.

6. Determination of magnifying power of a telescope.

7. To study series and parallel resonant LCR circuit.

8. Figure of merit of a galvanometer.

9. To measure voltage and Frequency of a sinusoidal wave form using a CRO and to find unknown frequency by producing Lissajous figure.

10. Resistance of a resister using Meter Bridge

FBEF461	RDBMS Lab	0-0-3	2

1. Use of SQL syntax: insertion, deletion, join, updation using SQL. (1 class)

2. Programs on join statements and SQL queries including where clause. (1 class)

3. Programs on procedures and functions. (1 class)

4. Programs on database triggers. (1 class)

5. Programs on packages. (1 class)

6. Programs on data recovery using check point technique. (1 class)

7. Concurrency control problem using lock operations. (1 class)

8. Programs on ODBC using either VB or VC++. (1 class)

9. Programs on JDBC. (1 class)

11. Programs on embedded SQL using C / C++ as host language. (1 class)

| FCYE408 | Chemistry -IV | 3-0-0 | 3 |

Carbohydrates   [08 Hrs]

Classification and nomenclature: Monosaccharides, mechanism of osazone formation, interconversion of glucose and fructose, chain lengthening and shortening of aldoses. Configuration of monosaccharides. Erythro and threo-diastereomers. Conversion of glucose into mannose.Formation of glycosides, ethers and esters. Determination of ring size of monosaccharides. Cyclic structure of D(+)-glucose . Mechanism of mutarotation.

Structure of ribose and deoxyribose.

An introduction to disaccharides (maltose, sucrose and lactose) and polysaccharides (starch and cellulose) without involving structure determination.

Coodination compounds   [05Hrs]

Warner's coordination theory and its experimental verification, effective atomic number concept, chelates, nomenclature of coordination compounds, isomerism in coordination compounds, valence bond theory of transition metal complexes.

Electrochemistry   [10 Hrs]

Types of reversible electrodes – gas-metal ion, metal-metal ion, metal-insoluble salt-anion and redox electrodes. Electrode reactions, Nernst equation, derivation of cell EMF and single electrode potential, standard hydrogen electrode- reference electrodes- standard electrode potential, sign conventions, electrochemical series and its significance.

Electrolytic and Galvanic cells – reversible and irreversible cells, conventional representation of electrochemical cells.

EMF of a cell and its measurements.Computation of cell EMF.Calculation of thermodynamic quantities of cell reactions (ΔG, ΔH and K), polarization, over potential and hydrogen overvoltage.

Concentration cell with and without transport, liquid junction potential, application of concentration cells, valency of ions, solubility product and activity coefficient, potentiometric titrations.

Definition of pH and pKa, determination of pH using hydrogen, quinhydrone and glass electrodes by potentiometric methods.

Buffers – mechanism of buffer action, Henderson – Hazel equation. Hydrolysis of salts. Corrosion types, theories and methods of combating it.

Solutions, Dilute Solutions and Colligative Properties   [07 Hrs]

Ideal and non-ideal solutions, methods of expressing concentrations of solutions, activity and activity coefficient.

Dilute solution, colligative properties, Raoult's law, relative lowering of vapour pressure, molecular weight determination. Osmosis, law of osmotic pressure and its measurement, determination of molecular weight from osmotic pressure. Elevation of boiling point and depression of freezing point. Thermodynamic derivation of relation between molecular weight and elevation in boiling point and depression in freezing point. Experimental methods for determining various colligative properties. Abnormal molar mass, degree of dissociation and association of solutes.

Essential readings:

- J.D. Lee, Concise Inorganic Chemistry, 5th edition, Blackwell Publishing, 2008
- Huheey, Keiter and Keiter, Inorganic chemistry Principle, structure and reactivity. 4Thedn
- Inorganic Chemistry R.D.Madan, S.Chand Publication
- Basic Inorganic Chemistry Cotton &Willikinson
- P.W. Atkins and Julio de Paula, Elements of Physical Chemistry, Oxofrd University Press, 1992
- Principles of Physical Chemistry by Puri, Sharma and Pathania, Vishal Publication Co
- Principles of Bio-Chemistry – Lehinger, Nelson and Cox
- Fundamentals of Bio-Chemistry – Voet&Voet
- Bio-Chemistry by Zubay
- Bio-Chemistry, Rastogi, Tata McGraw Hill

FCYE458	Chemistry Lab -IV	0-0-3	2

- ➢ 1. Detection of extra elements (N S and halogen),
- ➢ 2. Detection of functional groups containing C,H,O C,H,N in organic compounds
- ➢ 3. Determination of unknown organic compound
- ➢ 4. Organic preparations:
- ➢ a. Oxidation of ethanol/ isopropanol (Iodoform reaction).
- ➢ b. Hydrolysis of amides and esters.

FCYC501	Physical Chemistry-III	4-0-0	4

Module -I
Ionic equilibria:
Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases, pH scale, common ion effect; dissociation constants of mono-, di-and triprotic acids (exact treatment).

Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts. Buffer solutions; derivation of Henderson equation and its applications; buffer capacity, buffer range, buffer action and applications of buffers in analytical chemistry and biochemical processes in the human body. Solubility and solubility product of sparingly soluble salts – applications of solubility product principle. Qualitative treatment of acid – base titration curves (calculation of pH at various stages). Theory of acid–base indicators; selection of indicators and their limitations.

Multistage equilibria in polyelectrolyte systems; hydrolysis and hydrolysis constants.

Module -II
Solutions and Colligative Properties:
Dilute solutions; lowering of vapour pressure, Raoult's and Henry's Laws and their applications. Excess thermodynamic functions.

Thermodynamic derivation using chemical potential to derive relations between the four colligative properties [(i) relative lowering of vapour pressure, (ii) elevation of boiling point, (iii) Depression of freezing point, (iv) osmotic pressure] and amount of solute. Applications in calculating molar masses of normal, dissociated and associated solutes in solution.

Module -III
Phase Equilibria:
Concept of phases, components and degrees of freedom, derivation of Gibbs Phase Rule for nonreactive and reactive systems; Clausius-Clapeyron equation and its applications to solid-liquid, liquid-vapour and solid-vapour equilibria, phase diagram for one component systems, with applications. Phase diagrams for systems of solid-liquid equilibria involving eutectic, congruent and incongruent melting points, solid solutions.

Three component systems, water-chloroform-acetic acid system, triangular plots.

Binary solutions: Gibbs-Duhem-Margules equation, its derivation and applications to fractional distillation of binary miscible liquids (ideal and nonideal), azeotropes, lever rule, partial miscibility of liquids, CST, miscible pairs, steam distillation.

Nernst distribution law: its derivation and applications.

Selected Text / Reference Books:

1. Peter Atkins & Julio De Paula, *Physical Chemistry* 10th Ed*.,* Oxford University Press (2014).
2. Castellan, G. W. *Physical Chemistry*, 4th Ed., Narosa (2004).
3. McQuarrie, D. A. & Simon, J. D., *Molecular Thermodynamics*, Viva Books Pvt. Ltd.: New Delhi (2004).
4. Engel, T. & Reid, P. *Physical Chemistry 3rd Ed.,* Prentice-Hall (2012).
5. Assael, M. J.; Goodwin, A. R. H.; Stamatoudis, M.; Wakeham, W. A. & Will, S. *Commonly Asked Questions in Thermodynamics.* CRC Press: NY (2011).
6. Zundhal, S.S. *Chemistry concepts and applications* Cengage India (2011).
7. Ball, D. W. *Physical Chemistry* Cengage India (2012).
8. Mortimer, R. G. *Physical Chemistry 3rd Ed.,* Elsevier: NOIDA, UP (2009).
9. Levine, I. N. *Physical Chemistry 6th Ed.,* Tata McGraw-Hill (2011).
10. Metz, C. R*. Physical Chemistry 2nd Ed.,* Tata McGraw-Hill

FCYC502	Organic Chemistry-IV	4-0-0	4

Module I

Nature of Bonding in Organic Molecules:

Delocalised chemical bonding conjugation, cross conjugation, resonance, hyperconjugation, bonding in fullerenes, tautomerism.

Armaticity in benzenoid and nonbenzenoid compounds, alternant and non-alternant hydrocarbons.

Huckels rule, energy level of π- molecular orbitals, annulenes, antiaromaticity, Ψ-aromaticity, homo-aromaticity, PMO approach.

Bonds weaker than covalent, addition compounds, crown ether complexes and cryptands, inclusion compounds (cyclodextrins, catenanes and rotaxanes).

Module II

Stereochemistry:

Conformational analysis of cycloalkanes, decalins, effect of conformation on reactivity, conformation of sugars, steric strain due to unavoidable crowding.

Elements of symmetry, chirality, molecules with more than one chiral center, threo and erythro isomers, methods of resolution.

Optical purity, enantiotropic and diastereotopic atoms, groups and faces, stereospecific and stereoselective synthesis.

Optical activity in the absence of chiral carbon (biphenyls, allenes and spiranes), chirality due to helical shape.

Module III

Reaction Mechanism-I (Structure, Reactivity and Rearrangements):

Generation, structure, stability and reactivity of carbocations, carbanions, free radicals, carbenes and nitrenes.

Types of mechanisms: S_N2, S_N1, mixed S_N1 and S_N2 and SET, S_E1.

Kinetic and thermodynamic control, Hammond's postulate, Curtin-Hammett principle, potential energy diagrams, transition states and intermediates.

Methods of determining reaction mechanisms, isotope effects.

Hard and soft acids and bases concept and its application in organic synthesis.

Effect of structure on reactivity: resonance and field effects, steric effect.

Quantitative treatment, Hammet equation and linear free energy relationships, substituent and reaction constants, Taft equation.

The NGP mechanism, NGP by π and σ bonds, anchimeric assistance.

Classical and nonclassical carbocations, phenonium ions, norbornyl systems, common carbocation rearrangements.

The S_N1 mechanism, SN at an allylic, aliphatic trigonal and a vinyl carbon.

Reactivity effects of substrate structure, attacking nucleophile, leaving group and reaction medium, phase transfer catalysis and ultra sound, ambient nucleophile and regioselectivity.

Selected Text/Reference Books:

1.   March's Advanced Organic Chemistry: Reactions, Mechanisms, and Structure, Michael B. Smith, Jerry March, Sixth Edition, John Wiley & Sons, Inc.
2.   Advanced Organic Chemistry Part A: Structure and Mechanisms, **Carey**, Francis A., **Sundberg**, Richard J, Fifth Edition, Springer International Edition.
3.   A Guide Book to Mechanism in Organic Chemistry, Peter Sykes, Sixth Edition, John Wiley & Sons, Inc., New York.
4.   Structure and mechanism in organic chemistry, von C. K. Ingold. Cornell Univ. Press, Ithaca. 1953
5.   Organic Chemistry, R. T. Moririson and R. N. Boyd, Sixth Edtion, Prentice-Hall
6.   Modern Organic Reactions, H. O. House. Benjamin.

7.   Principles of Organic Synthesis, R. O. C. Norman and J.M.Coxon, Third Edition, Blackie Academic and Professional

8.   *Pericyclic Reactions*: A Mechanistic Study.*S. M. Mukherji Macmillan India* Press, New Delhi

9.   Reaction Mechanism in Organic Chemistry, S. M. Mukherjii and S. P. Singh, Third Edition Macmillan *India* Press, New Delhi

10.   Stereochemistry of Organic Compounds. D. Nasipuri,Third Edition, New Age International.

11.   Stereochemistry of Organic Compounds. P.S.Kalsi, Sixth Edition, New Age International.

12.   Organic Synthesis: Clayden J., Greeves N, Warren S, and Wouthers, Second Edition Oxford University Press,

FCYC503	Inorganic Chemistry-IV	4-0-0	4

Module I

Stereochemistry and Bonding in Main Group Compounds

VSEPR Theory, Walsh diagrams, $d\pi$-$p\pi$ bonds, Bent rule and energies of hybridization, some simple reactions of covalently bonded molecules.

Metal - Ligand Bonding

Limitations of CFT, MOT: sigma bonding and energy level diagram in octahedral, tetrahedral and square planar complexes; pi-bonding and energy level diagram in octahedral complexes, angular overlap model.

Module II

Electronic spectra of coordination compounds

Spectroscopic ground states, term symbols for d^n ions, Racah parameters, selection rules and intensities of bands, Orgel diagram, correlation and Tanaube-Sugano diagrams, spectra of 3d metal-aqua complexes of trivalent metal ions (d^1-d^6), divalent Mn, Co and Ni, $CoCl_4^{2-}$, calculation of Dq, B and β parameters, CT spectra.

Spectral properties of lanthanide and actinide metal complexes.

Module III

Metal-ligand Equilibria in Solution

Stability of metal complexes, Stepwise and overall stability constant, factors affecting the stability constant, determination of stability constants and their applications, compositions of metal complexes by Job's method..

Inorganic reaction mechanism

Reactivity of metal complexes, inert and labile complexes, factors affecting the reactivity of complexes, mechanisms of substitution (acid, base and anation) reactions of octahedral complexes, isotope effects, Berry's pseudo rotation, Swain-Scott equation, substitution reactions of square planar complexes, trans-effect – theories and applications in synthesis of metal complexes, Redox reactions: mechanism of one election transfer reaction (inner sphere and outer-sphere), Marcus theory for outer-sphere reactions.

Selected Text/Reference Books:

1.   D. F. Shriver, P. W. Atkins, *Inorganic Chemistry,* 3rd Edn., Oxford University, Oxford, 1999.
2.   N. N. Greenwood, A. Earnshaw, *Chemistry of the Elements,* Pergamon Press, 2nd Edn., 2002.
3.   B. Douglas, D. McDaniel, and J. Alexander, Concepts and Models of Inorganic Chemistry, 3rd Edn., John Wiley, New York. 1993
4.   D. Katakis, and G. Gordon, *Mechanism of Inorganic Reactions*, John Wiley & Sons: N. Y (1987).
5.   J. E. Huheey, E. A. Keiter, R. L. Keiter & O. K. Medhi,   *Principles of Structure and Reactivity (1st impression)*, Pearson Education, 2006.
6.   F. Basolo & R. G. Pearson, *Mechanism of Inorganic Reactions*, Wiley Eastern, 1967.
7.   F. A. Cotton, G. Wilkinson, C. A. Murillo & M. Bochmann, *Advanced Inorganic Chemistry,* 6th Edn, John Wiley, 1999.
8.   R. G. Wilkins, *The Study of Kinetics and Mechanism of Reactions of Transition Metal Complexes,* Allyn & Bacon, Boston, 1974.
9.   Robert B. Jordan, *Reaction Mechanisms of Inorganic and Organometallic Systems,* Oxford University Press, 1998.
10.   A.K. Das and M. Das, *Fundamental Concept of Inorganic Chemistry,* Vol. 4 and 5, CBS Publisher & Distributor Pvt. Ltd., New Delhi, 2014.

FCYE504	Instrumental Methods of Chemical Analysis	3-0-0	4

Module I

Tools and Data Handling: Balances, burettes, volumetric flasks, pipettes, calibration of tools, sampling. Errors and Statistics: significant figures, rounding off, accuracy and precision, determinate and indeterminate errors, standard deviation, propagation of errors, confidence limit, test of significance, rejection of a result.

Module II

Separation Techniques: Solvent Extraction: distribution Coefficient, distribution ratio, solvent extraction of metals, multiple batch extraction, counter current distribution. - Chromatographic Techniques: classification, theory of chromatographic separation, distribution coefficient, retention, sorption, efficiency and resolution. - Column, ion exchange, paper, TLC & HPTLC: techniques and application. - Gas Chromatography: retention time or volume, capacity ratio, partition coefficient, theoretical plate and number, separation efficiency and resolution, instrumentation and application.

Module III

Spectroscopic Techniques: Electromagnetic radiation, absorption, and emission of radiation – instrumentation: sources, monochromators, detectors. - Flame spectrometry: flame emission, AAS, ICP, instrumentation and application. - Absorption spectrometry: UV-VIS, IR, instrumentation, techniques and applications.

Selected Text/Reference Books:

1. Willard, Merritt, Dean, Settle, *Instrumental Methods of Analysis*, 7th ed, IBH Book House, New Delhi.
2. Atkins, P.W & Paula, J.D. *Physical Chemistry*, 10th Ed., Oxford University Press (2014).
3. Kakkar, R. *Atomic and Molecular Spectroscopy: Concepts and Applications.* Cambridge University Press, 2015.
4. Castellan, G. W. *Physical Chemistry 4th Ed.,* Narosa (2004).
5. Banwell, C. N. & McCash, E. M. *Fundamentals of Molecular Spectroscopy* 4th Ed. Tata McGraw-Hill: New Delhi (2006).
6. Smith, B.C. *Infrared Spectral Interpretations: A Systematic Approach.* CRC Press, 1998.
7. Moore, W.J., *Physical Chemistry* Orient Blackswan, 1999.
8. D. C. Harris, Quantitative Chemical Analysis, 4th Ed., W. H. Freeman, 1995
9. G. D.Christian & J. E. O'Reily, Instrumental Analysis, 2nd Ed., Allyn & Balon, 1986
10. D. A. Skoog, F. J. Holler, S. R. Crouch, Instrumental Analysis, Cengage Learning, 11th edn., 2012.

| FCYE505 | Symmetry and Group Theory | 3-1-0 | 3 |

Module I
Basic Group theory , Molecular symmetry, Symmetry Groups
Algebraic Systems – Common properties of Operators – Levels of Abstraction – Subsystems – Direct Products – Isomorphisms - Axioms and theories of group – Abelian and cyclic groups – Finite sub-groups and Homomorphisms - Similarity Transformation and Classes - Cosets and Permutation Groups.

Symmetry Elements and operations – Planes – Axes - Inversions – Improper Axes – Products of Symmetry Operations – Equivalence symmetry elements and operations – Relations between symmetry operations – Classes – Symmetry groups with multiple higher order axes – Symmetry Point groups – Matrix representation of symmetry operations

Module II
Group Theory in Molecular Quantum Chemistry
Representation of groups - Character - Reducible and Irreducible Representations - Great Orthogonality Theorem - Construction of Character Tables – Cyclic groups - Double groups - Direct Products – Complete and Incomplete Projection Operators – Constructions of Symmetry adapted Linear Combinations.

Module III
Applications
Symmetry properties of Hamiltonian operator - Wave functions as basis for Irreducible Representations - Transition moment integrals - selection rule for spectral transitions - Mutual exclusion principle – LCAO – MO Approximation – Symmetry factoring of secular equations-Ligand field theory – Molecular Vibrations – Woodward-Hoffmann Cyclization rules.

Selected Text/Reference Books:
1.   F. A. Cotton: Chemical Applications of Group Theory, Wiley Eastern, 1985.
Further Reading:
2.   A. M. Lesk, Introduction to symmetry and group theory for chemists, Kluwer, NY, 2004.
3.   A. Vincent, Molecular Symmetry and Group theory, A Programmed Introduction to chemical applications, Wiley, New York, 2001.
4.   R. L. Carter, Molecular Symmetry and Group theory, Wiley, NY, 1997.
5.   R. B. Woodward and R. Hoffmann, Conservation of Orbital symmetry, Verlag Chemie GmbH, NY, 1970.
6.   Symmetry and Spectroscopy of Molecules, 2nd Edtion, K. V. Reddy, New Age International Publishers

| FCYC551	Physical Chemistry Lab-I	0-0-3	2

I.   Determination of critical solution temperature and composition of the phenol-water system and to study the effect of impurities on it.

II.   Phase equilibria: Construction of the phase diagram using cooling curves or ignition tube method:

a.   simple eutectic and
b.   congruently melting systems.
III.   Distribution of acetic/ benzoic acid between water and cyclohexane.

IV.   Study the equilibrium of at least one of the following reactions by the distribution method:

(i) $I_2(aq) + I^- \rightarrow I_3^-(aq)^{2+}$

(ii) $Cu^{2+}(aq) + nNH_3 \rightarrow Cu(NH_3)_n$
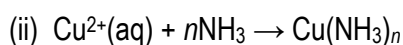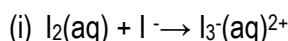
V.   Study the kinetics of the following reactions.

1. Initial rate method: Iodide-persulphate reaction
2. Integrated rate method:
a. Acid hydrolysis of methyl acetate with hydrochloric acid.
b. Saponification of ethyl acetate.
3. Compare the strengths of HCl and H_2SO_4 by studying kinetics of hydrolysis of methyl acetate.

VI. Adsorption
I.   Verify the Freundlich and Langmuir isotherms for adsorption of acetic acid on activated charcoal.

Selected Text/Reference Books:

1. Khosla, B. D.; Garg, V. C. & Gulati, A. *Senior Practical Physical Chemistry,* R. Chand & Co.: New Delhi (2011).
2. Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. *Experiments in Physical Chemistry 8th Ed.*; McGraw-Hill: New York (2003).
3. Halpern, A. M. & McBane, G. C. *Experimental Physical Chemistry 3rd Ed.;* W.H. Freeman & Co.: New York (2003).

| FCYC552 | Organic Chemistry-Lab-I | 0-0-3 | 2 |

1. Detection of extra elements.
2. Functional group test for nitro, amine and amide groups.
   Qualitative analysis of unknown organic compounds containing simple functional groups (alcohols, carboxylic acids, phenols and carbonyl compounds)
3. Extraction of caffeine from tea leaves.

4. Preparation of sodium polyacrylate.
5. Preparation of urea formaldehyde.
6. Analysis of Carbohydrate: aldoses and ketoses, reducing and non-reducing sugars.
7. Qualitative analysis of unknown organic compounds containing monofunctional groups (carbohydrates, aryl halides, aromatic hydrocarbons, nitro compounds, amines and amides) and simple bifunctional groups, for e.g. salicylic acid, cinnamic acid, nitrophenols, etc.
8. Identification of simple organic compounds by IR spectroscopy and NMR spectroscopy (Spectra to be provided).
   9. Preparation of methyl orange.

Selected Text/Reference Books:

1. Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry,* Pearson Education (2009)
2. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. *Practical Organic Chemistry, 5th Ed.,* Pearson (2012)
3. Ahluwalia, V.K. & Aggarwal, R. *Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis,* University Press (2000).
4. Ahluwalia, V.K. & Dhingra, S. *Comprehensive Practical Organic Chemistry: Qualitative Analysis,* University Press (2000).
5. Vogel, A.I. *Quantitative Organic Analysis,* Part 3, Pearson (2012).

| FCYC553 | Inorganic Chemistry Lab-I | 0-0-3 | 2 |

Gravimetric Analysis:
i. Estimation of nickel (II) using Dimethylglyoxime (DMG).
ii. Estimation of copper as CuSCN
iii. Estimation of iron as Fe_2O_3 by precipitating iron as $Fe(OH)_3$.

iv. Estimation of Al (III) by precipitating with oxine and weighing as $Al(oxine)_3$ (aluminium oxinate).

Inorganic Preparations:
i. Tetraamminecopper (II) sulphate, $[Cu(NH_3)_4]SO_4.H_2O$
ii. *Cis* and *trans* $K[Cr(C_2O_4)_2. (H_2O)_2]$ Potassium dioxalatodiaquachromate (III)
iii. Tetraamminecarbonatocobalt (III) ion
iv. Potassium tris(oxalate)ferrate(III)

Chromatography of metal ions

Principles involved in chromatographic separations. Paper chromatographic separation of following metal ions:
i. Ni (II) and Co (II)
ii. Fe (III) and Al (III)

Selected Text/Reference Books:
Mendham, J., *A. I. Vogel's Quantitative Chemical Analysis 6th Ed.,* Pearson, 2009.

| FCYC601 | Physical Chemistry-IV | 4-0-0 | 4 |

Module I
Conductance
Arrhenius theory of electrolytic dissociation. Conductivity, equivalent and molar conductivity and their variation with dilution for weak and strong electrolytes. Molar conductivity at infinite dilution. Kohlrausch law of independent migration of ions. Debye-Hückel-Onsager equation, Wien effect, Debye-Falkenhagen effect, Walden's rules.

Ionic velocities, mobilities and their determinations, transference numbers and their relation to ionic mobilities, determination of transference numbers using Hittorf and Moving Boundary methods. Applications of conductance measurement: (i) degree of dissociation of weak electrolytes, (ii) ionic product of water (iii) solubility and solubility product of sparingly soluble salts, (iv) conductometric titrations, and (v) hydrolysis constants of salts.

Module II
Electrochemistry
Quantitative aspects of Faraday's laws of electrolysis, rules of oxidation/reduction of ions based on half-cell potentials, applications of electrolysis in metallurgy and industry.

Chemical cells, reversible and irreversible cells with examples. Electromotive force of a cell and its measurement, Nernst equation; Standard electrode (reduction) potential and its application to different kinds of half-cells. Application of EMF measurements in determining

(i) free energy, enthalpy and entropy of a cell reaction, (ii) equilibrium constants, and (iii) pH values, using hydrogen, quinone-hydroquinone, glass and SbO/Sb_2O_3 electrodes. Concentration cells with and without transference, liquid junction potential; determination of activity coefficients and transference numbers. Qualitative discussion of potentiometric titrations (acid-base, redox, precipitation).

Module III
Photochemistry
Characteristics of electromagnetic radiation, Lambert-Beer's law and its limitations, physical significance of absorption coefficients. Laws, of photochemistry, quantum yield, actinometry, examples of low and high quantum yields, photochemical equilibrium and the differential rate of photochemical reactions, photosensitised reactions, quenching. Role of photochemical reactions in biochemical processes, photostationary states, chemiluminescence.

Selected Text / Reference Books:

1.   Peter Atkins & Julio De Paula, *Physical Chemistry* 10th Ed*.,* Oxford University Press (2014).
2.   Castellan, G. W. *Physical Chemistry*, 4th Ed., Narosa (2004).
3.   McQuarrie, D. A. & Simon, J. D., *Molecular Thermodynamics*, Viva Books Pvt. Ltd.: New Delhi (2004).
4.   Engel, T. & Reid, P. *Physical Chemistry 3rd Ed.,* Prentice-Hall (2012).
5.   Assael, M. J.; Goodwin, A. R. H.; Stamatoudis, M.; Wakeham, W. A. & Will, S.
Commonly Asked Questions in Thermodynamics. CRC Press: NY (2011).
6.   Zundhal, S.S. *Chemistry concepts and applications* Cengage India (2011).
7.   Ball, D. W. *Physical Chemistry* Cengage India (2012).
8.   Mortimer, R. G. *Physical Chemistry 3rd Ed.,* Elsevier: NOIDA, UP (2009).
9.   Levine, I. N. *Physical Chemistry 6th Ed.,* Tata McGraw-Hill (2011).
10.   Metz, C. R. *Physical Chemistry 2nd Ed.,* Tata McGraw-Hill (2009).

FCYC602	Inorganic Chemistry-V	4-0-0	4

Module-I
Magnetic properties of coordination compounds

Types of magnetic behaviour, magnetic susceptibility and its determination by Gouy, Faraday and VSM method, Pascal's constants and constitutive corrections, paramagnetism, Curie-Weiss law, Van Vleck's equation (derivation exluded) and its applications, spin-orbit coupling, ferro- and anti-ferromagnetism coupling, super paramagnetism, high and low spin equilibria.

Anomalous magnetic moments, magnetic exchange coupling and spin crossover.

Magnetic properties of Lanthanide and Actinide metal complexes.

Module-II
Organometallic chemistry-I

Stability and 18 electron rules (covalent and ionic),

Alkyls/aryl and hydrides: alkyls and aryls (metal alkyls stabilized carbanion, β-elimination, stable alkyls, agostic alkyls, reductive elimination, preparation of metal allyls).

Metal hydrides: synthesis, characterization, reactions, bridging hydrides.

Pi-complexes: Synthesis, bonding, properties and applications of alkenes and alkynes, allyls, diene, cyclopentane, dienyl, arenes.

Introductory idea on transition metal-carbon multiple compounds: carbene and carbyne.

Module-III
Organometallic chemistry-II

Reactivity of organo-transition metal complexes: Coordinative unsaturation, substitution reactions (nucleophilic and electrophilic addition and abstraction), oxidative addition and reductive elimination, insertion reactions (insertion of CO, SO_2 and alkenes).

Catalysis by organo-transition metal complexes: Alkene isomerisation, hydrogenation and hydroformylation; Zeigler-Natta polymerization of ethylene, reduction of carbon monoxide by hydrogen (Fischer-Tropsch reaction).

Fluxional Organometallic Compounds

Fluxionality and dynamic equilibria in compounds such as η^2- olefin, η^3- allyl and dienyl complexes.

Selected Text / Reference Books:

1. Robert H. Crabtree, The Organometallic Chemistry of the Transition Metals , by , Wiley 2014
2. John F. Hartwig, **Organotransition Metal Chemistry: From Bonding to Catalysis** by , University Science Books, 2009
3. Anthony F. Hill, Organotransition Metal Chemistry, Royal Society of Chemistry,
4. Tutorial Chemistry Text, 2002. Chapters 1 to 7.
5. Organometallics: A concise Introduction, Ch. Elshebroicn and A Salzer, VCH, 2006.
6. Organotransition Metal Chemistry: Applications to Organic Synthesis, S.G.Davies, Pergamon 1982.
7. A.K. Das and M. Das, *Fundamental Concept of Inorganic Chemistry,* Vol. 4 and 5, CBS Publisher & Distributor Pvt. Ltd., New Delhi, 2014.
8. R.C. Mehrotra and A. Singh, *Organometallic Chemistry,* New Age International Publishers, 2nd Edn, 2000.
9. R.L. Dutta and A. Samal, Elements of Magnetochemistry, S. Chand & Company Ltd., 1982.

| FCYC603 | Quantum Theory | 3-1-0 | 4 |

Module-I

Quantum Chemistry-I: Operators in Quantum mechanics: Linear, Hermitian and Angular Momentum operators, Eigenvalue problem.

Basic postulates of quantum mechanics. The Schrodinger equation, Particle in 1,2 and 3-dimensional boxes, degeneracy.

Module-II

Quantum Chemistry-II: Harmonic oscillator, Spherical Coordinates: Rigid rotator, Solution of the Schrodinger equation for Hydrogen like atoms, Significance of n, l and m quantum numbers. Linear Variation and Perturbation Methods. Multielectron atoms, spin quantum number, Ground and excited state of helium atom.

Module-III

Quantum Chemistry-III: Hydrogen Molecule ion, Born-Oppenheimer approximation, LCAO-MO approximation, Hydrogen Molecule, Valence Bond and Molecular Orbital Theory. Homonuclear and heternuclear diatomic molecules (HF, CO, NO)

Selected Text / Reference Books:

1.   D. A. McQuarrie and J. D. Simon, Physical Chemistry: A Molecular Approach, Viva Student Edition, 2015.

2.   D. A. McQuarrie, Quantum Chemistry, Viva Student Edition, 2015.

3.   M. S. Gopinathan and V. Ramakrishnan, Group Theory in Chemistry, Vishal Publishers, 1988.

4.   Cotton, F. A. Chemical Applications of Group Theory, 3rd Edn., John Wiley and Sons, 2003.

5.   N. Levine, 'Quantum Chemistry', 4th Edn., Prentice Hall India, 2001.

6.   A. K. Chandra, Introductory Quantum Chemistry, Tata McGraw Hill, 1994.

7.   Jack Simons, Introduction to Theoretical Chemistry, Cambridge University Press, 2003.

8.   P. W. Atkins. Molecular Quantum Mechanics, Oxford University Press (1986).

| FCYF604 | Environmental Chemistry | 3-1-0 | 4 |

Module – I

Ecological Concepts: Biotic components, Ecosystem Process: Energy, Food Chain, Water cycle, Oxygen cycle, Nitrogen cycle, carbon cycle, Environmental gradients, Tolerance levels of environment factor, EU, US and Indian Environmental Law. Chemistry in Environmental Engineering: Atmospheric chemistry, Soil chemistry. Noise pollution- Noise standards, measurement and control. Water Treatment: water quality standards and parameters, Ground water. Water treatment processes, Pre-treatment of water, Conventional process, Advanced oxidation process.

Module – II

(a) Waste Water Treatment: COD and BOD of Waste water treatment process, pretreatment, primary and secondary treatment of waste water, Activated sludge treatment: Anaerobic digestion, Reactor configurations and methane production.

(b) Air Pollution : Air pollution and pollutants, criteria of pollutants, Acid deposition, Global climate change –greenhouse gases, air pollution meteorology, Atmospheric dispersion. Industrial Air Emission Control. Flue gas desulphurization, NOx removal, Fugitive emissions.

(c) Solid waste, Hazardous waste management, Solid Waste Management, Source classification and composition of MSW: Separation, storage and transportation, Reuse and recycling, zero waste management, Hazardous Waste Management, Hazardous waste and their generation, Transportation and treatment: Incinerators,super critical liquids, Inorganic waste treatment. E.I.A., Environmental auditing,

Module – III

Occupational Safety and Health Acts, Safety procedures, Type of Accidents, Chemical and Heat Burns, Prevention of Accidents involving Hazardous substances, Human error and Hazard Analysis. Hazard Control Measures in integrated steel industry, Petroleum Refinery, L.P.G. Bottling, Pharmaceutical industry. Fire Prevention – Detection, Extinguishing Fire, Electrical Safety, Product Safety. Safety Management- Safety Handling and Storage of Hazardous Materials, Corrosive Substances, Gas Cylinders, Hydro Carbons and Wastes. Personal Protective Equipments.

Selected Text / Reference Books:

1. Environmental Engineering Irwin/ McGraw Hill International Edition, 1997, G. Kiely,
2. Industrial Safety Management, L. M. Deshmukh, Tata McGraw Hill Publication.
3. Chemistry for Environmental Engineering and Science, Clair N. Sawyer, Perry L. Mc Carty and Gene F. Parkin, 5th edition, Mc GrawHill
4. Environmental Engineering by Arcadio P. Sincero & Gergoria A. Sincero PHI Publication
5. Principles of Environmental Engineering and Science, M. L. Davis and S. J. Masen, McGraw Hill International Edition, 2004
6. Environmental Science, Curringham & Saigo, TMH,
7. An Introduction to Environmental Engineering and Science by Gilbert M. Masters & Wendell P. Ela - PHI Publication.
8. Industrial Safety Management and Technology, Colling. D A – Prentice Hall, New Delhi.

FCYF605	Solid State Chemistry	3-0-0	3

Module I

Chemical crystallography

Introduction, Space lattice, Crystal point groups, space group (working knowledge), Stereographic projections, Packing in solids, Crystal structures of representative systems, Silicates and Zeolites, Cements, Glasses, Quasicrystals, Nanostructures.

Bonding in solids and Crystal energetics

Crystal classifications, Madelung constant and Lattice energy.

Module-II

Electronic properties and Band theory of solids

Free electron model, Metals, semiconductors and insulators, doped semiconductors
Solid state ionics.

Defects, Nonstoichiometry and Diffusion

Point defects, Dislocations, Extended defects, Clusters and aggregates, Color centres, Non-stoichiometry of compounds, Diffusion mechanisms, Fick's law, Kirkenall effect.

Phase transitions

Critical phenomena, variety of phase transitions (Ordered- disorder, Martensite-austenite, Spinoidal decompositions etc), Liquid crystals, Structure-property relations (magnetic, electrical, superconductivity, optical and thermal).

Module- III

Preparative and characterization techniques

Powder synthesis by conventional and modern chemical methods, Reactivity of solids, Decomposition mechanisms, Powder processing (sintering and diffusion processes), Tailoring of solids, Special methods for single crystal growth and thin films depositions.

Characterization techniques (working knowledge) for solids

X-ray diffraction, Electron microscopy (SEM, TEM, AFM), Spectroscopic techniques (Mossbauer, IR, UV-VIS) and Physical property measurement techniques (Magnetic moments-VSM /SQUID, Electrical resistivity – Two / Four probe methods and thermal conductivity, Optical band gap, XPS, XAS).

Selected Text / Reference Books:

1. A. R. West, Solid State chemistry and its applications, 2nd edition, John Wiley & Sons,.
2. L. Smart and E. Moore, Solid State chemistry: An Introduction, 4th edition, Chapman and Hall.
3. A. K. Cheetham and P. Day, Solid state chemistry compounds, Clarendon Press, Oxford 1992.
4. C. N. R. Rao and J. Gopalkrishanan, New directions in solid state chemistry, Cambridge Univ. Press 1997.
5. S.E. Dann, Reactions and Characterization of Solids, , ISBN 0-471-22481-2
6. A.R. West , Basic Solid State Chemistry, Wiley, 3rd edition, 2012
7. Christopher Hammondhy, The Basics of Crystallography and Diffraction (International Union of Crystallography Texts on Crystallograp), **Wiley** 2009

| FCYC651 | Physical Chemistry Lab-II | 0-0-3 | 2 |

Conductometry
I. Determination of cell constant
II. Determination of equivalent conductance, degree of dissociation and dissociation constant of a weak acid.
III. Perform the following conductometric titrations:
  i. Strong acid vs. strong base
  ii. Weak acid vs. strong base
  iii. Mixture of strong acid and weak acid vs. strong base
  iv. Strong acid vs. weak base

Potentiometry
I Perform the following potentiometric titrations:
  i. Strong acid vs. strong base
  ii. Weak acid vs. strong base
  iii. Dibasic acid vs. strong base
  iv. Potassium dichromate vs. Mohr's salt

Selected Text / Reference Books:

1. Khosla, B. D.; Garg, V. C. & Gulati, A. *Senior Practical Physical Chemistry,* R. Chand & Co.: New Delhi (2011).

2. Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. *Experiments in Physical Chemistry 8th Ed.;* McGraw-Hill: New York (2003).

   Halpern, A. M. & McBane, G. C. *Experimental Physical Chemistry 3rd Ed.;* W.H. Freeman & Co.: New York (2003).

FCYC652	Inorganic Chemistry Lab-II	0-0-3	2

Qualitative semimicro analysis of mixtures containing 3 anions and 3 cations. Emphasis should be given to the understanding of the chemistry of different reactions. The following
radicals are suggested:

CO_3^{2-}, NO_2^-, S^{2-}, SO_3^{2-}, $S_2O_3^{2-}$, CH_3COO^-, F^-, Cl^-, Br^-, I^-, NO_3^-, BO_3^{3-}, $C_2O_4^{2-}$, PO_4^{3-}, NH_4^+, K^+, Pb^{2+}, Cu^{2+}, Cd^{2+}, Bi^{3+}, Sn^{2+}, Sb^{3+}, Fe^{3+}, Al^{3+}, Cr^{3+}, Zn^{2+}, Mn^{2+}, Co^{2+}, Ni^{2+}, Ba^{2+}, Sr^{2+}, Ca^{2+}, Mg^{2+}

Mixtures should preferably contain one interfering anion, **or** insoluble component ($BaSO_4$, $SrSO_4$, $PbSO_4$, CaF_2 or Al_2O_3) **or** combination of anions e.g. CO_3^{2-} and SO_3^{2-}, NO_2^- and NO_3^-, Cl^- and Br^-, Cl^- and I^-, Br^- and I^-, NO_3^- and Br^-, NO_3^- and I^-.
Spot tests should be done whenever possible.

i.   Measurement of 10 Dq by spectrophotometric method
ii. Verification of spectrochemical series.
iii. Controlled synthesis of two copper oxalate hydrate complexes: kinetic vs thermodynamic factors.
v.   Preparation of acetylacetanato complexes of Cu^{2+}/Fe^{3+}. Find the λmax of the complex.
vi. Synthesis of ammine complexes of Ni(II) and its ligand exchange reactions (e.g. bidentate ligands like acetylacetone, DMG, glycine) by substitution method.

Selected Text / Reference Books:

1. Vogel's *Qualitative Inorganic Analysis,* Revised by G. Svehla. Pearson Education, 2002.

2. Marr & Rockett *Practical Inorganic Chemistry.* John Wiley & Sons 1972.

FCYC653	Instrumental Methods of Chemical Analysis Lab	0-0-3	2

1. Safety Practices in the Chemistry Laboratory

2. Determination of the isoelectric pH of a protein.
3. Titration curve of an amino acid.
4. Determination of the void volume of a gel filtration column.
5. Determination of a Mixture of Cobalt and Nickel (UV/Vis spec.)
6. Study of Electronic Transitions in Organic Molecules (i.e., acetone in water)
7. IR Absorption Spectra (Study of Aldehydes and Ketones)
8. Determination of Calcium, Iron, and Copper in Food by Atomic Absorption
9. Quantitative Analysis of Mixtures by Gas Chromatography (i.e., chloroform and carbon tetrachloride)

10. Separation of Carbohydrates by HPLC
11. Determination of Caffeine in Beverages by HPLC
12. Potentiometric Titration of a Chloride-Iodide Mixture
13. Cyclic Voltammetry of the Ferrocyanide/ Ferricyanide Couple
14. Nuclear Magnetic Resonance
15. Use of fluorescence to do "presumptive tests" to identify blood or other body fluids.
16. Use of "presumptive tests" for anthrax or cocaine
17. Collection, preservation, and control of blood evidence being used for DNA testing
18. Use of capillary electrophoresis with laser fluorescence detection for nuclear DNA (Y chromosome only or multiple chromosome)

19. Use of sequencing for the analysis of mitochondrial DNA
20. Laboratory analysis to confirm anthrax or cocaine
21. Detection in the field and confirmation in the laboratory of flammable accelerants or explosives

22. Detection of illegal drugs or steroids in athletes
23. Detection of pollutants or illegal dumping
24. Fibre analysis
    At least 10 experiments to be performed.

Selected Text / Reference Books:

1. Skoog, D.A. Holler F.J. & Nieman, T.A. *Principles of Instrumental Analysis*, Cengage Learning India Ed.

2. Willard, H.H., Merritt, L.L., Dean, J. & Settoe, F.A. *Instrumental Methods of Analysis*, 7th Ed. Wadsworth Publishing Company Ltd., Belmont, California, USA, 1988.